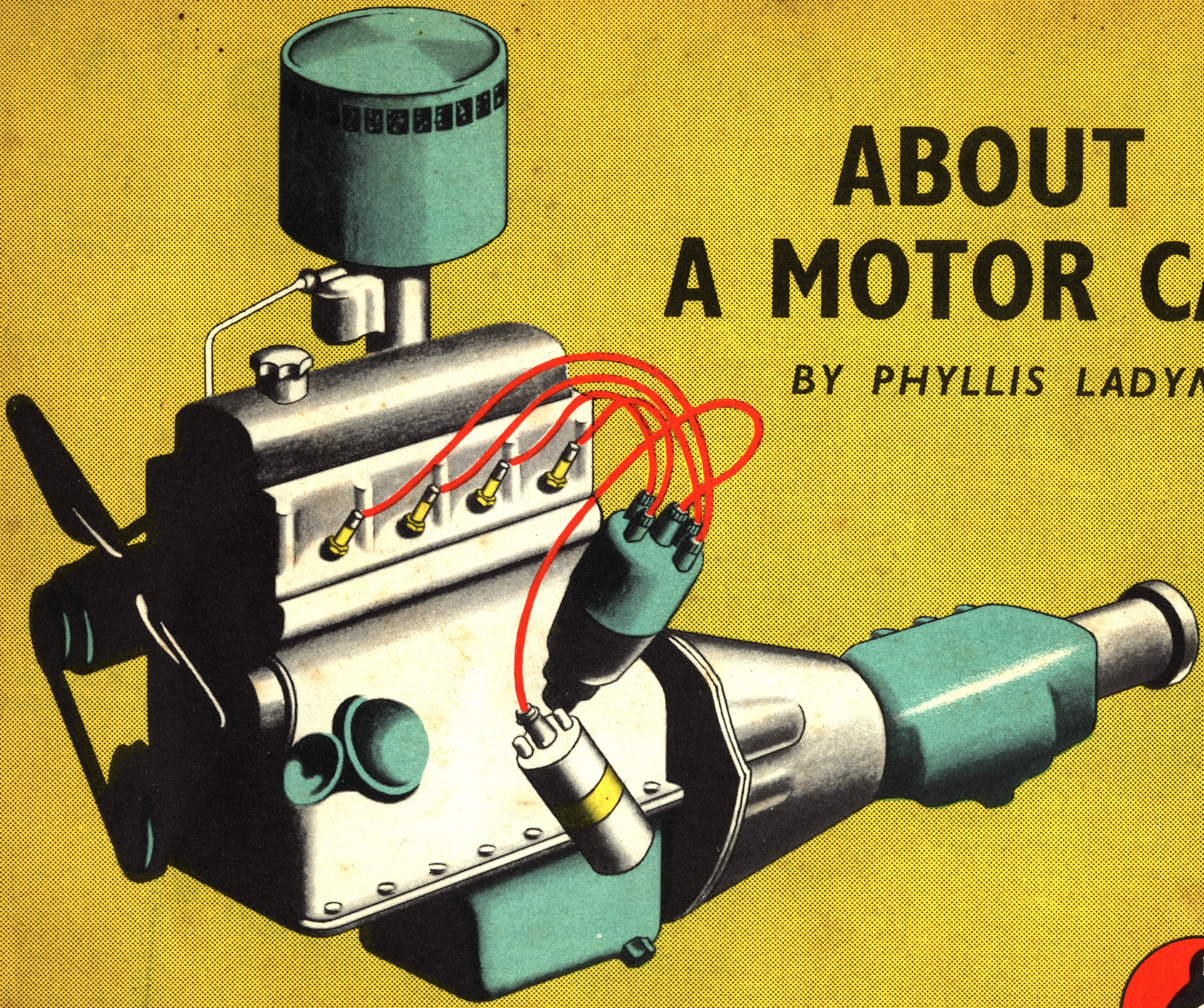


ABOUT A MOTOR CAR

BY PHYLLIS LADYMAN

PUFFIN PICTURE BOOK 38

2/6

PUFFIN PICTURE BOOKS

PUBLISHED BY PENGUIN BOOKS LTD · HARMONDSWORTH · MIDDLESEX

EDITED BY NOEL CARRINGTON

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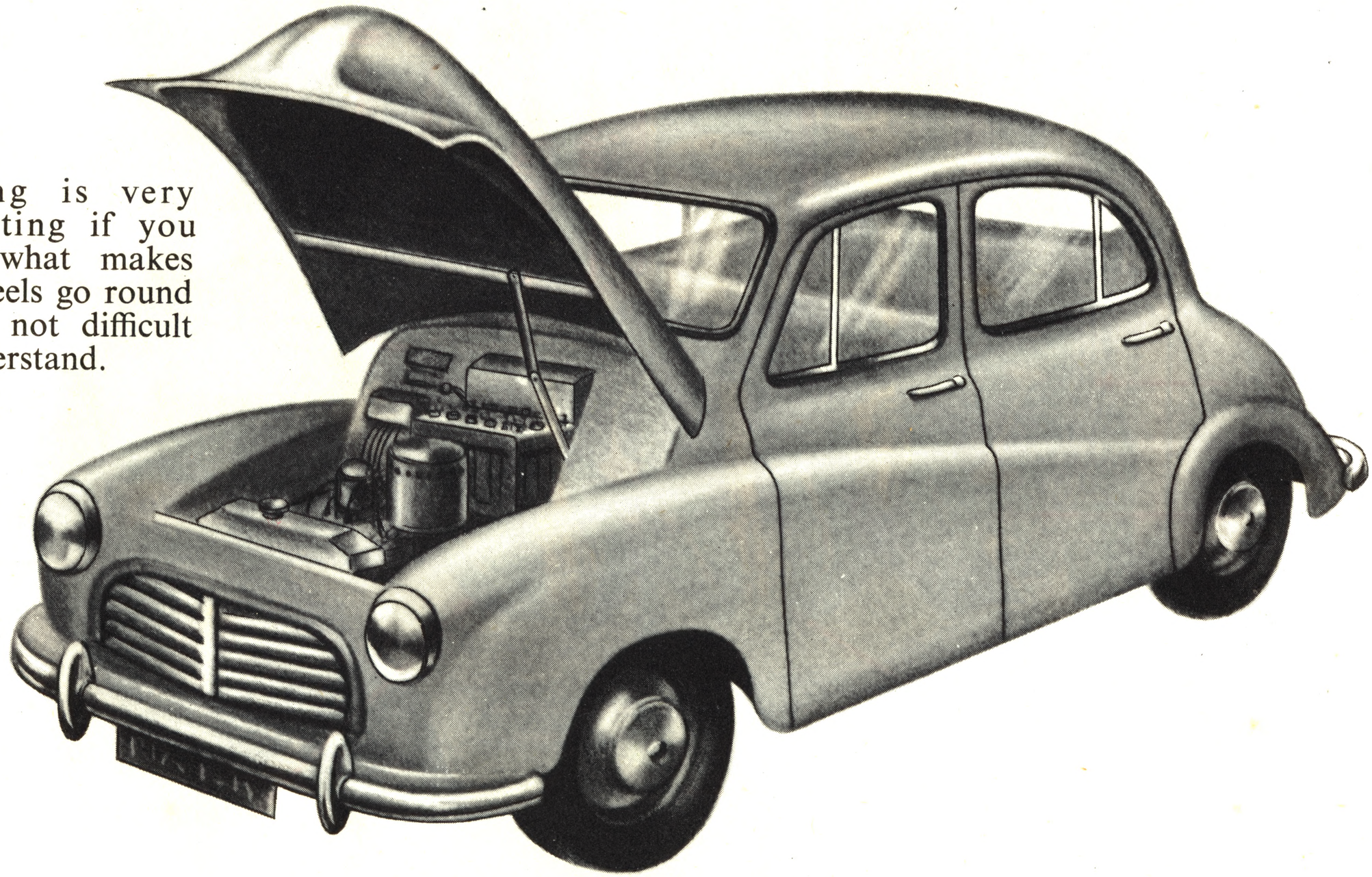
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This volume printed in England by W. S. Cowell Ltd, Ipswich
First published 1946. Reprinted 1948, 1951. Revised edition 1956

About a Motor Car

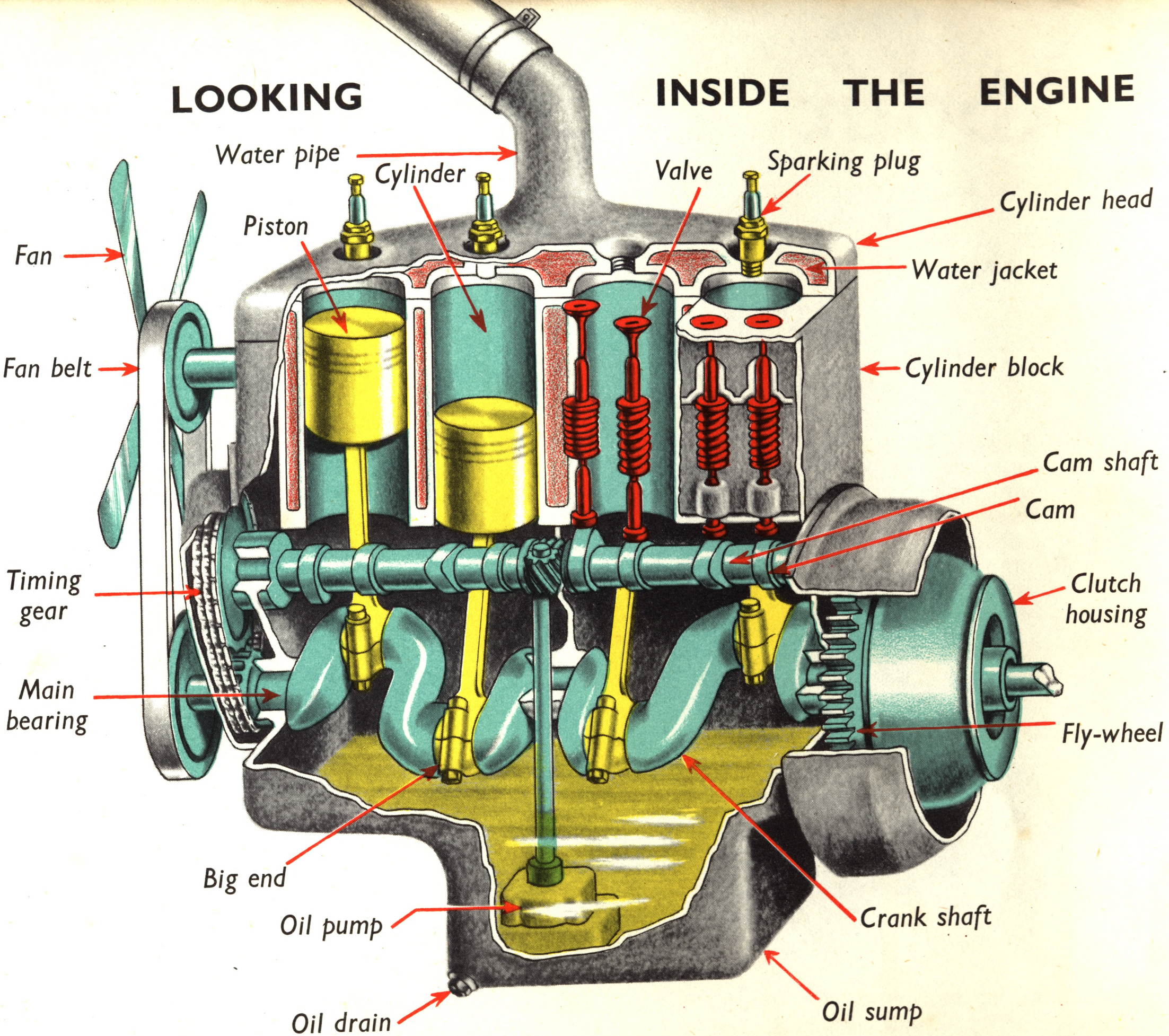
A motor car seems a simple thing. The driver sits in his seat, pulls one knob and presses another, puts his feet on the pedals and away he goes, as if by magic. It seems so simple, but perhaps that is because we take it all for granted and do not bother our heads about the mystery of how it works and what makes it go. A lot of people do not know how their own car works.

Driving is very interesting if you know what makes the wheels go round and is not difficult to understand.



It is much better for the car, too, as you know how to take care of it. The car lasts longer, gives less trouble, and runs better, so let's see what all the pedals, knobs and switches are for.

LOOKING INSIDE THE ENGINE



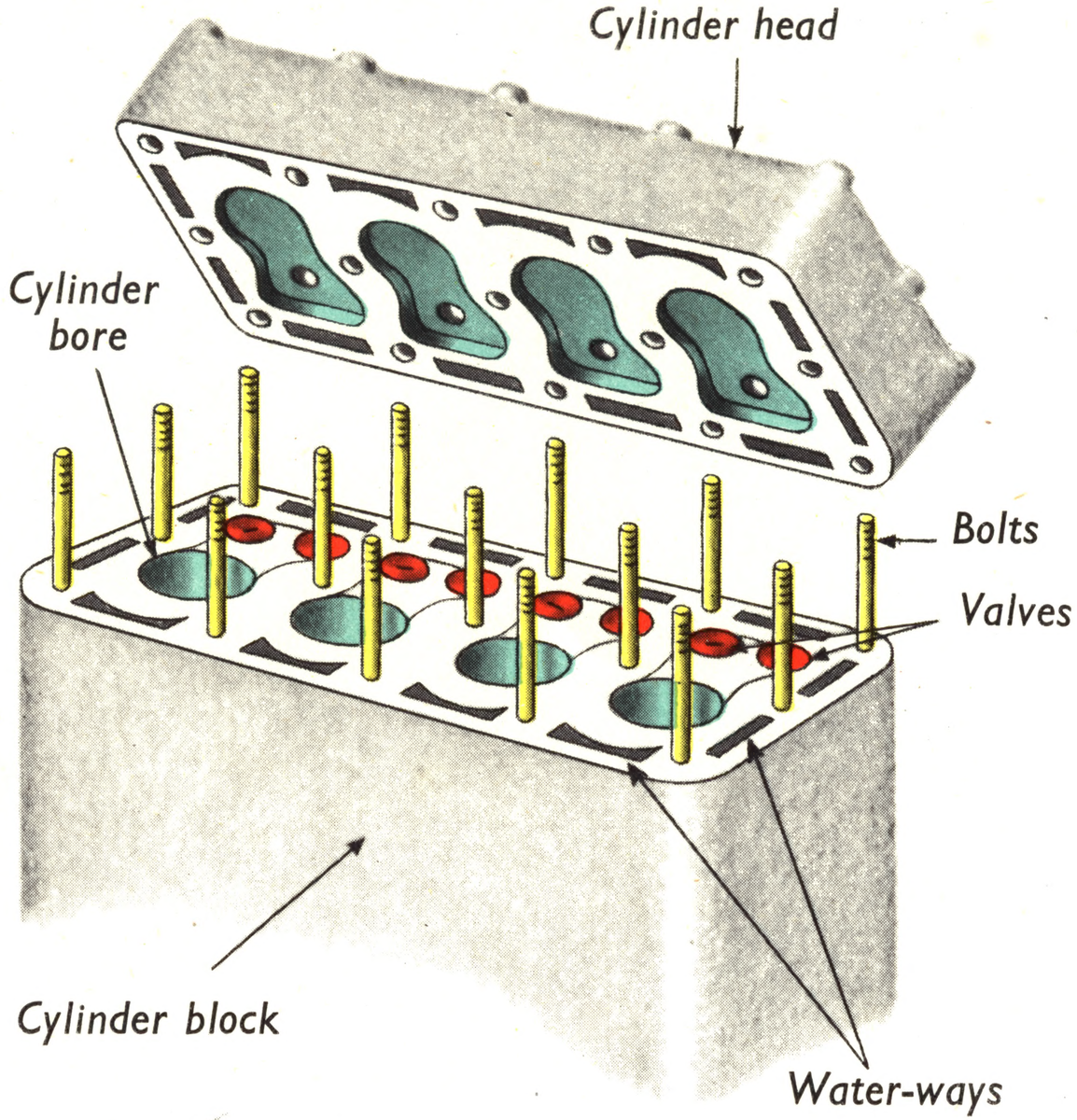
HERE IT IS . . . IN PIECES

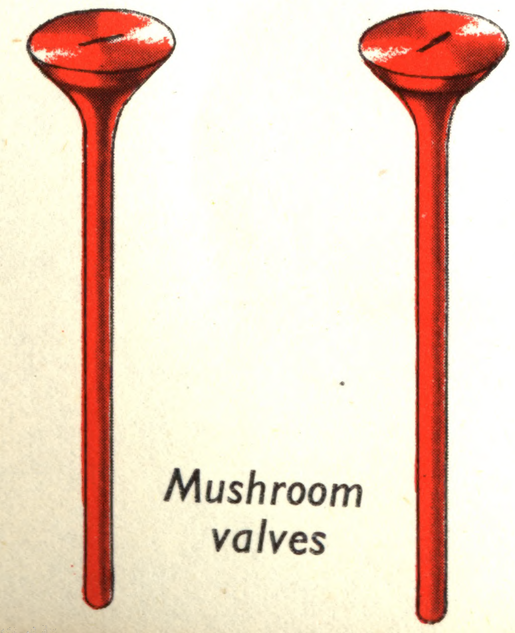
CYLINDERS are round holes bored in the iron cylinder block; they are very smooth and polished. This motor car engine has four. More powerful engines can have six, or eight, or sometimes twelve.

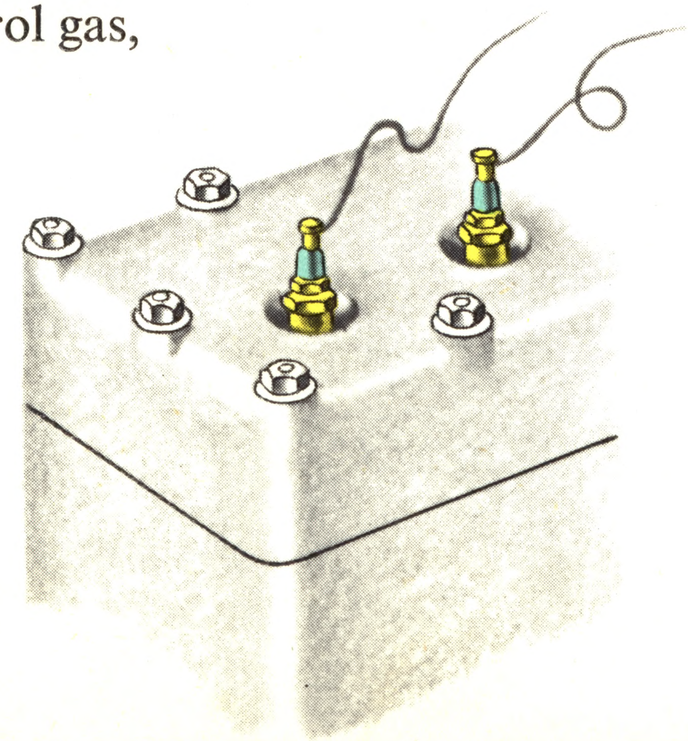
CYLINDER HEAD, also made of iron, and bolted to the cylinder block, is like a lid and closes up the top of the cylinders, making each a separate airtight container. Each cylinder has two pipes leading into it. One lets in petrol gas, and the other lets out the hot waste fumes after the explosion.

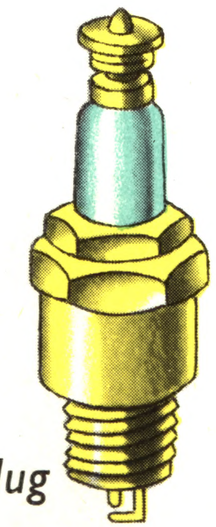
TWO VALVES, shaped like mushrooms, and called mushroom valves, open and shut these pipes. They are like stoppers and have sloping sides to make a tight fit. They have to open and shut at the right moment.

THE SPARKING PLUGS are screwed into the cylinder head, one over each cylinder. The electric spark from the plug sets fire to the petrol gas, again at the right moment.

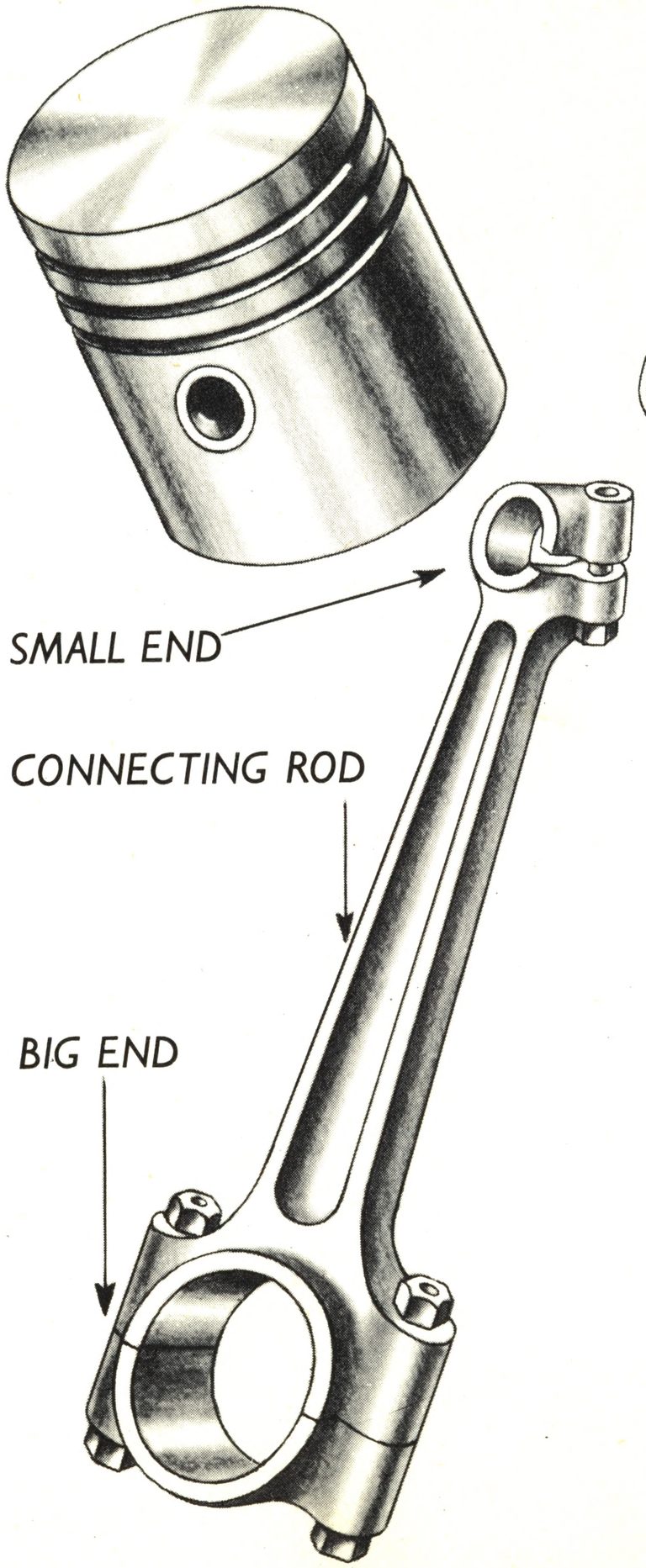


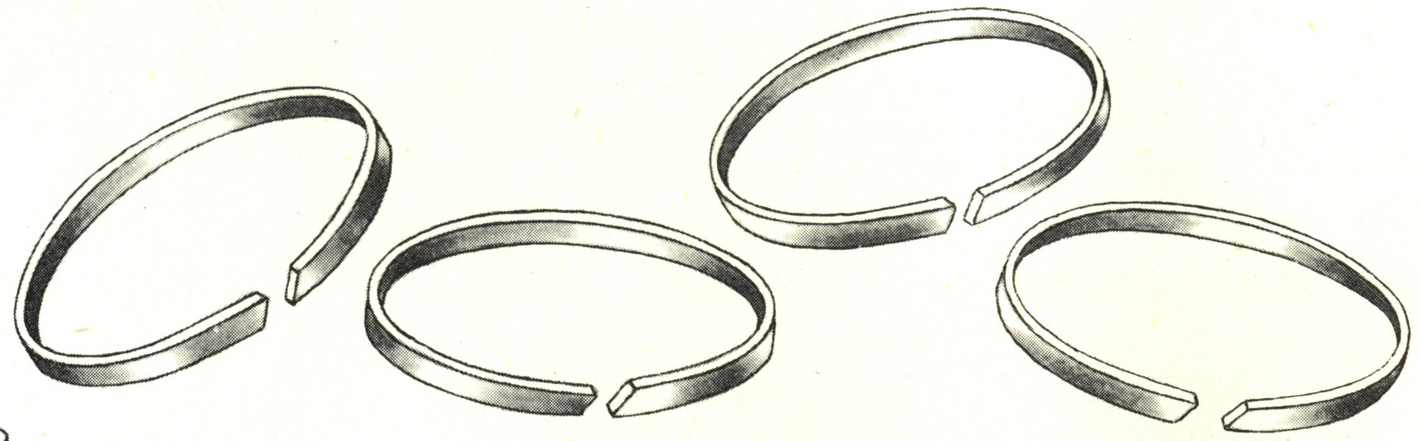

Mushroom valves



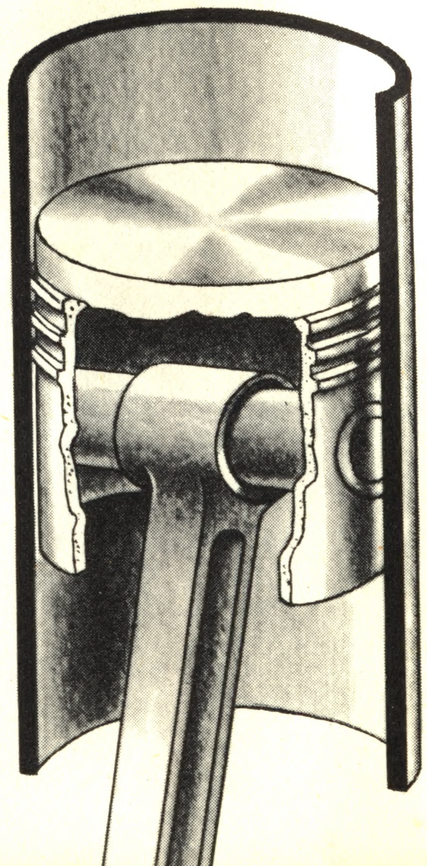

Sparking plug

Piston and Piston Rings



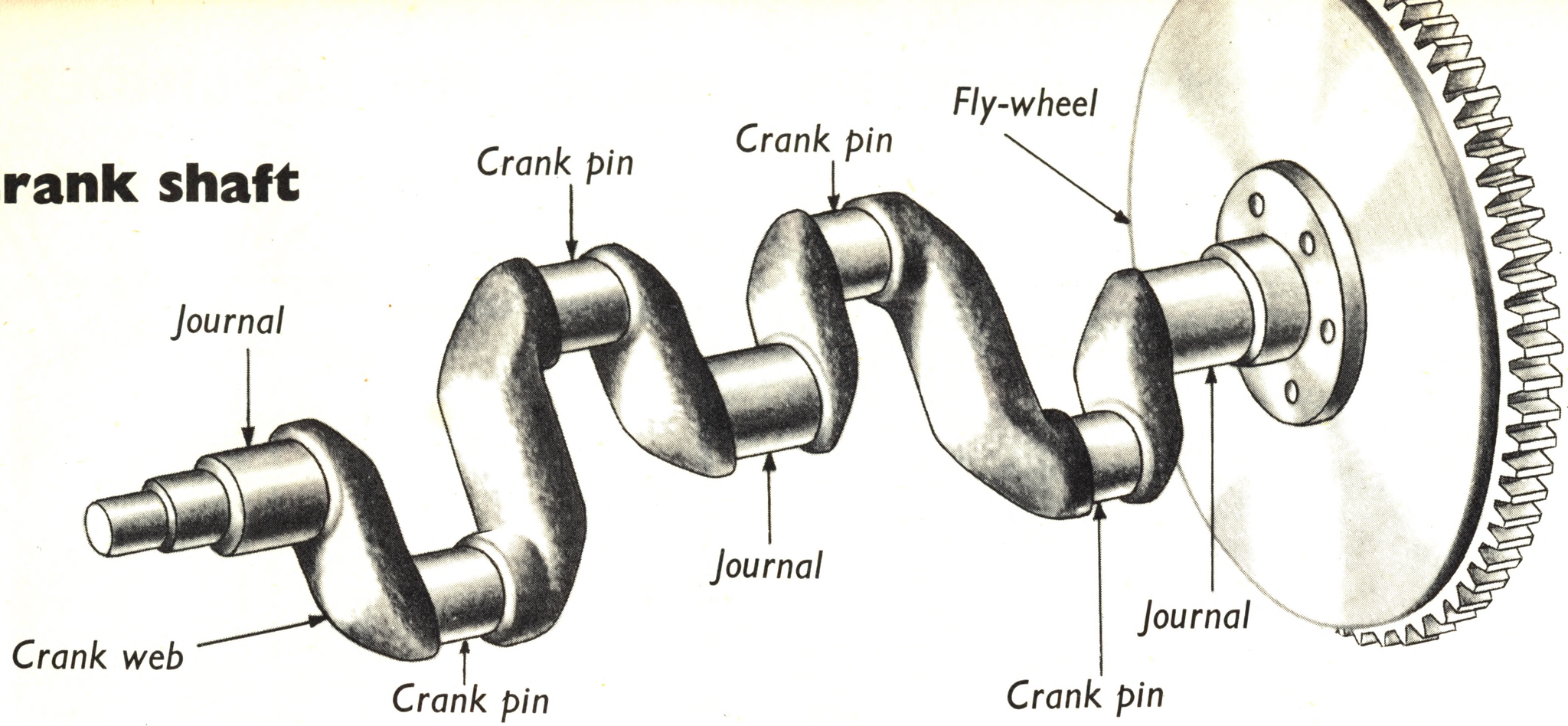


Inside each cylinder is an aluminium piston that is driven up and down. It must be a very tight fit so that none of the petrol gas can get past. Piston rings prevent this happening. These are made of springy iron and are slit. They are fitted into square grooves cut into the piston and press outwards to make the piston a leak-proof fit in the cylinder. If the cylinder gets worn with long use or lack of oil, and is no longer a tight fit, some of the gas escapes. Then the piston loses some of its power and petrol and oil are wasted. The connecting rod joins the piston to the crank shaft. It is made from steel forgings. The top end is hinged to the piston, and the bottom end, called the big end, is made in two pieces that fit round the crank pin and are fastened by bolts.

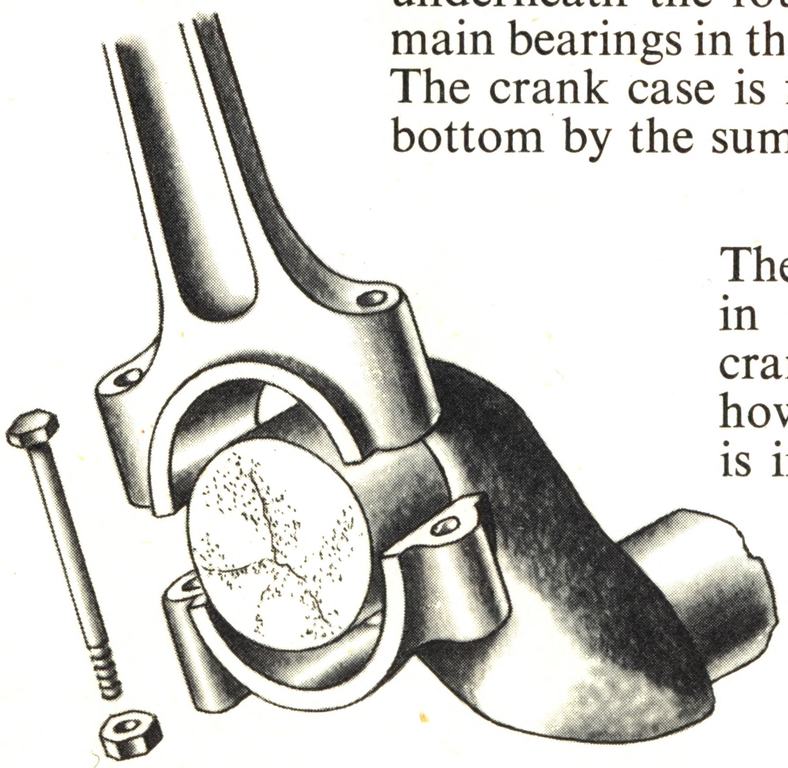


A cylinder cut in half showing piston

Crank shaft

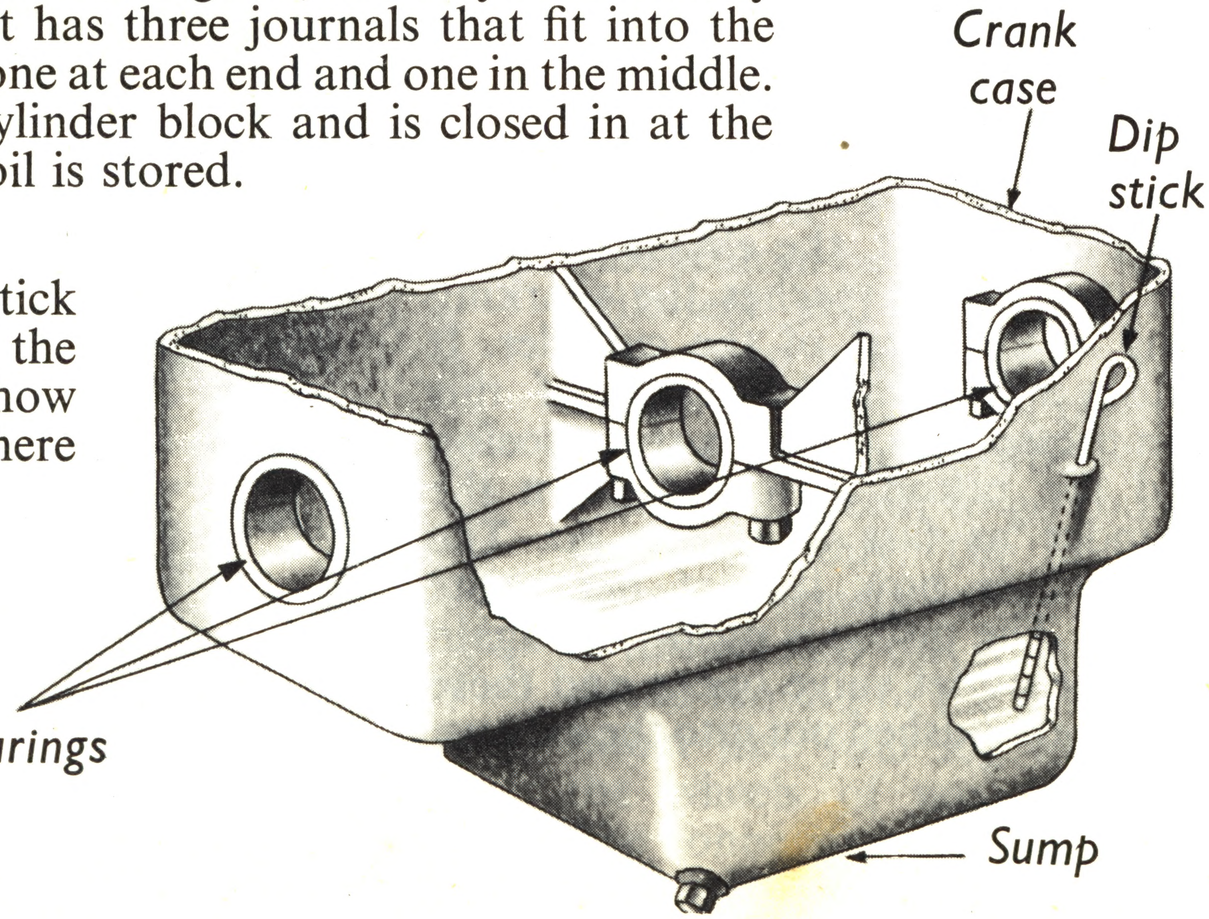


The crank shaft is made all in one piece from a steel forging. This one has four crank pins, one for each connecting rod, and they come exactly underneath the four cylinders. It has three journals that fit into the main bearings in the crank case, one at each end and one in the middle. The crank case is fixed to the cylinder block and is closed in at the bottom by the sump where the oil is stored.



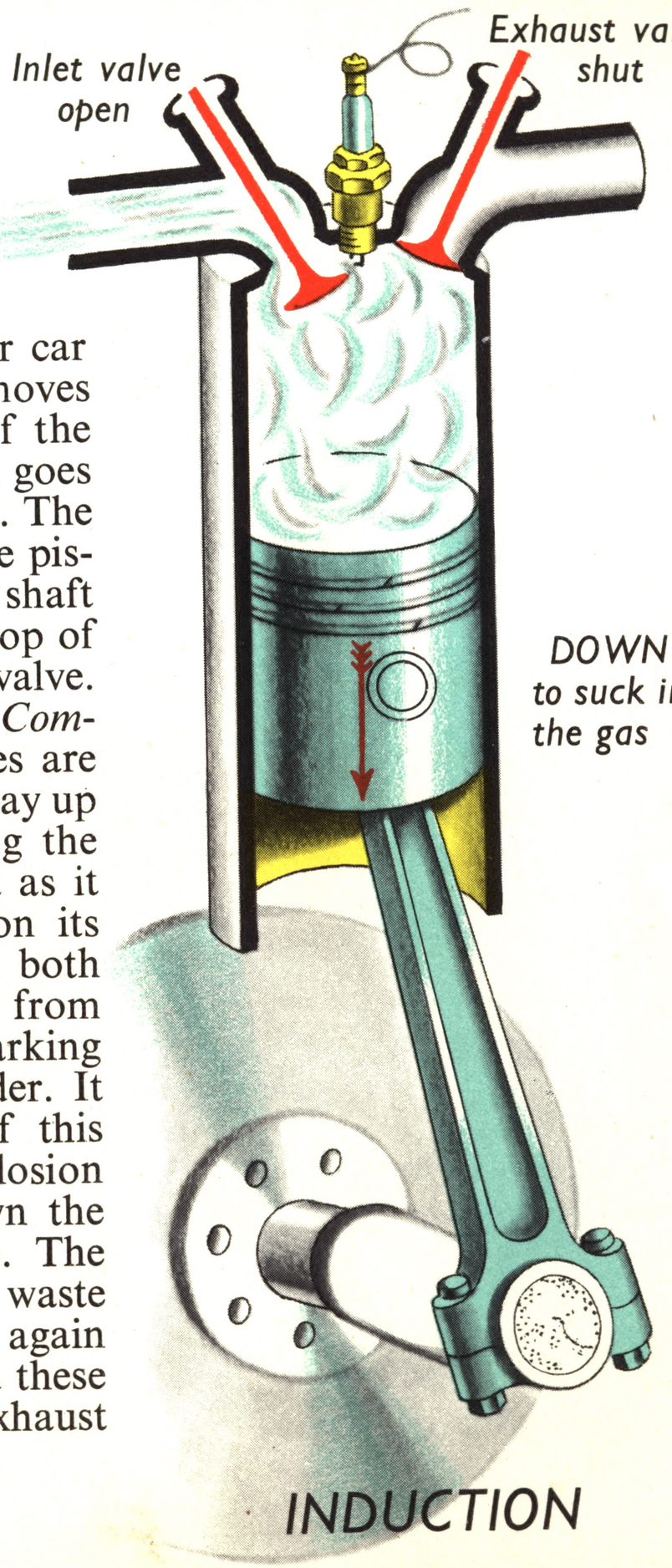
Big end bolted round crank pin

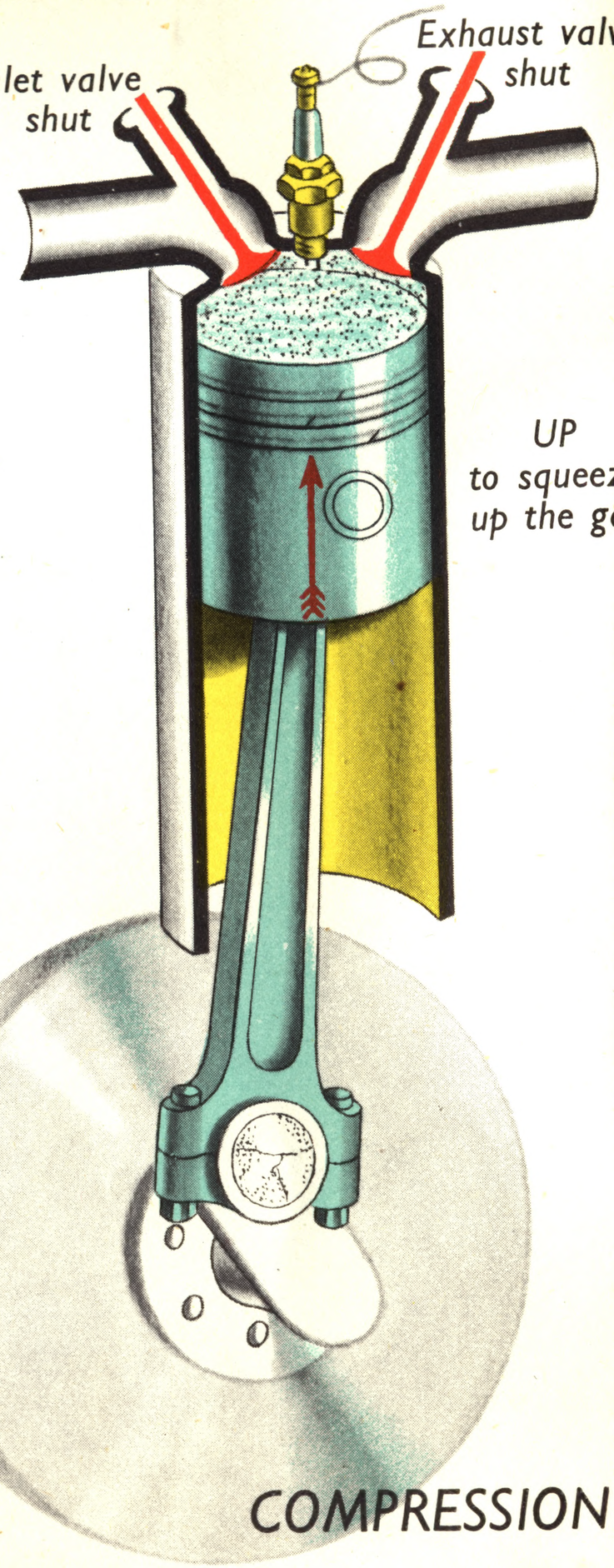
There is a dip stick in the side of the crank case to show how much oil there is in the sump.



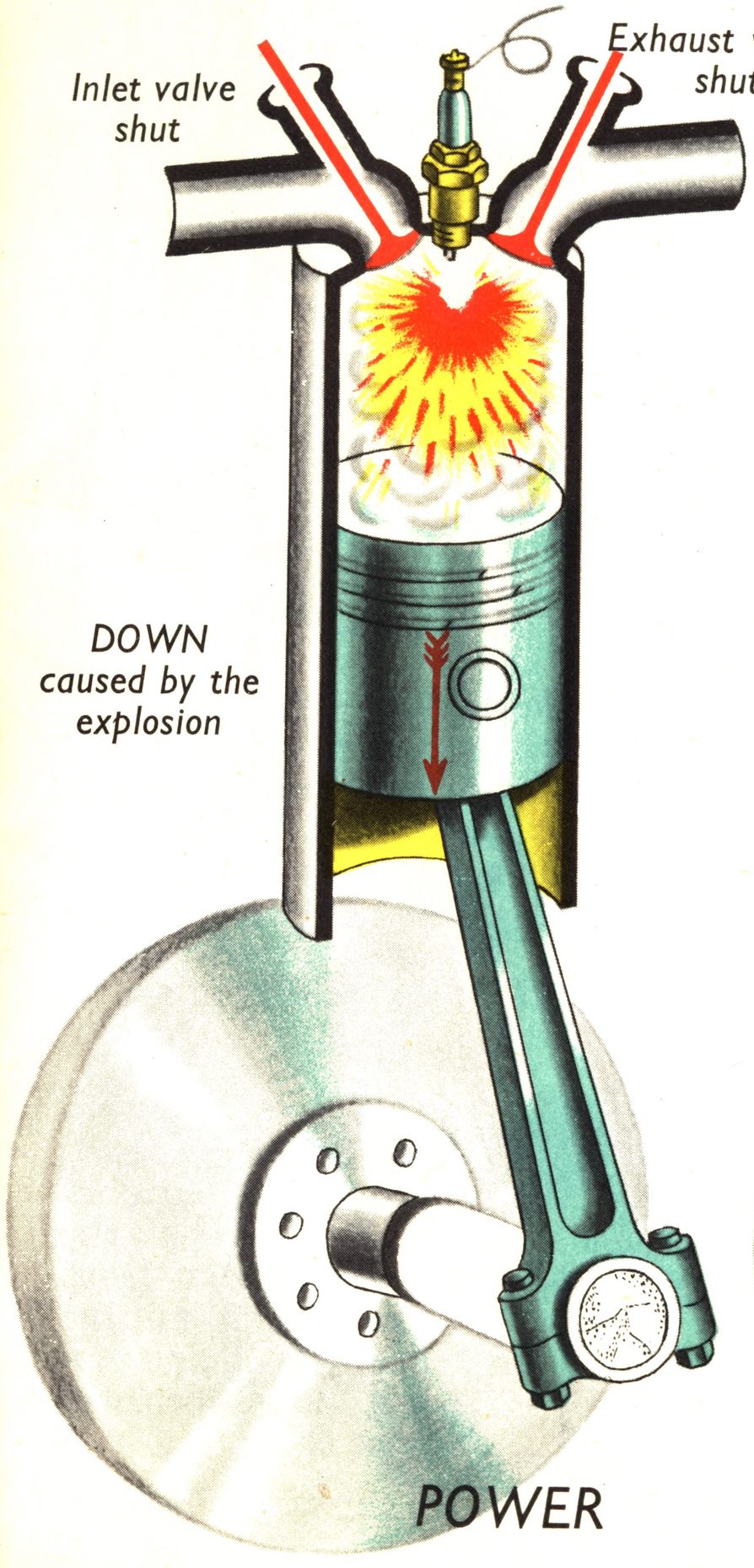
THIS IS WHAT HAPPENS INSIDE THE CYLINDER

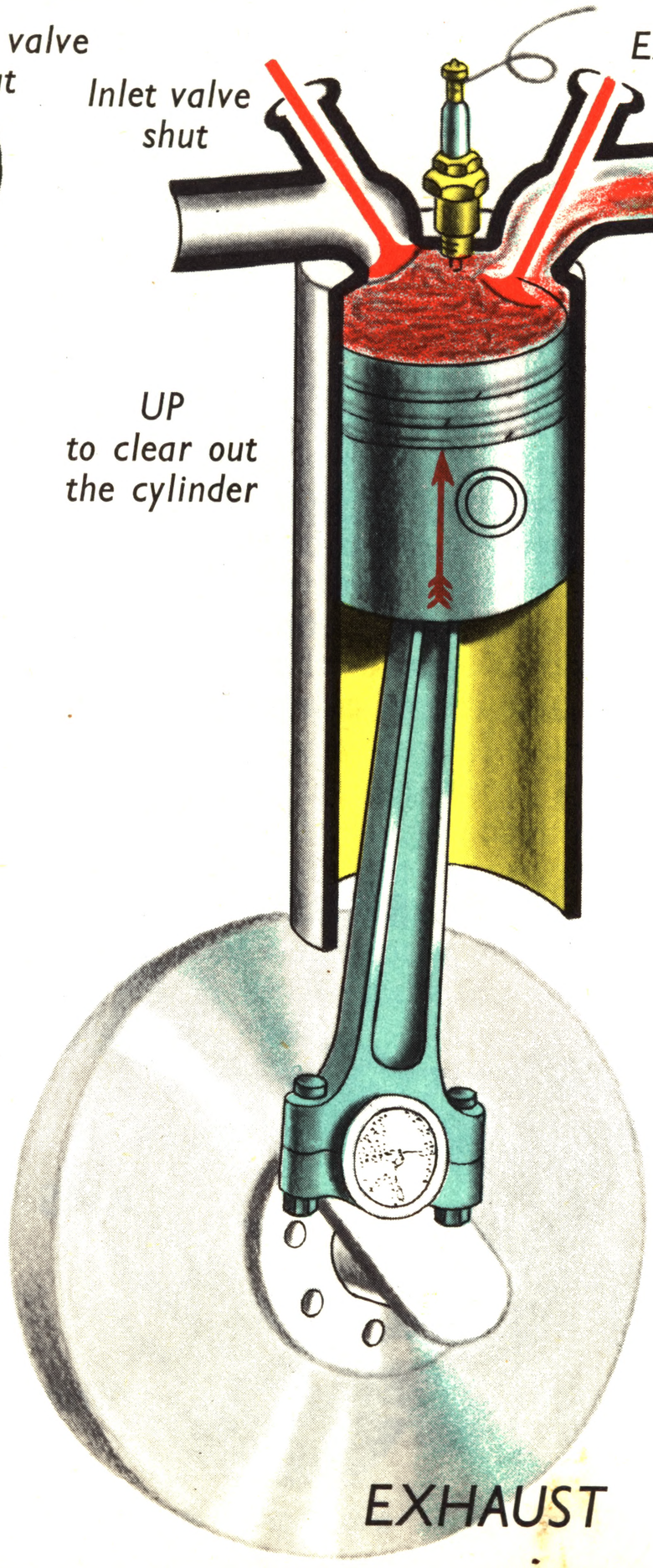
When petrol is turned into vapour, and mixed with air, it forms a gas that explodes easily when a spark touches it. This is the gas used in a motor car engine. The distance the piston moves from the top to the bottom of the cylinder is called the 'stroke'. It goes through a series of four strokes. The first is the *Induction Stroke*. The piston is pulled down by the crank shaft and the gas is sucked into the top of the cylinder through the inlet valve. The second stroke is called the *Compression Stroke*. Both the valves are shut, and the piston pushes its way up the air-tight cylinder, squeezing the mixture into a tiny space. Just as it is about to go down again, on its third stroke, the *Power Stroke*, both valves still shut, the electricity from the distributor reaches the sparking plug in the head of the cylinder. It causes a spark in the middle of this compressed gas. There is an explosion and the piston is forced down the cylinder as fast as it can go. The cylinder is now full of hot waste fumes. The piston is pushed up again and the outlet valve opens and these fumes are pushed out into the exhaust pipe.





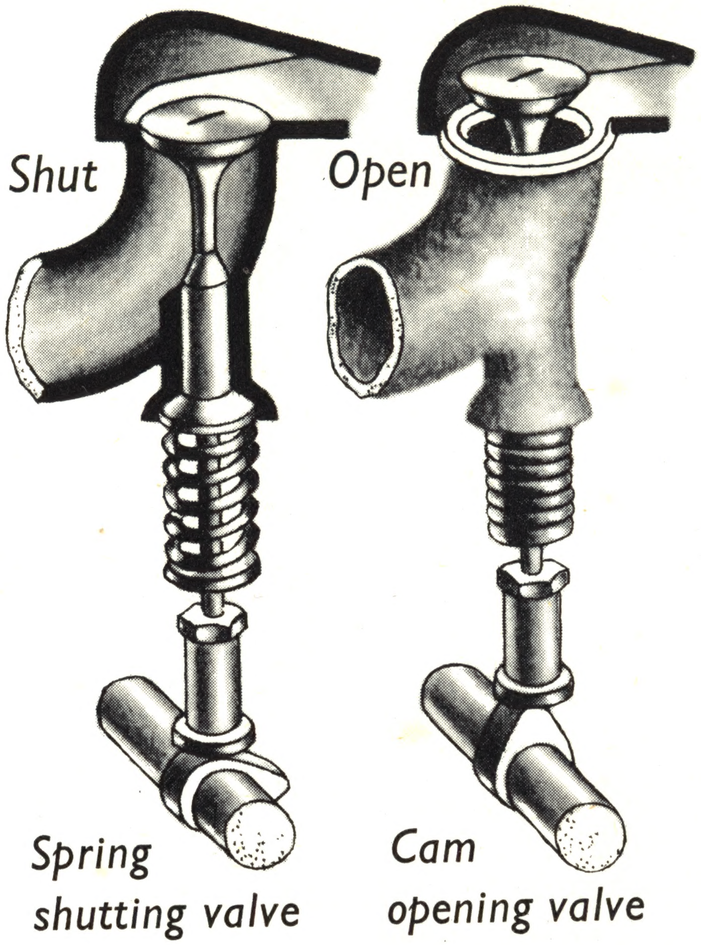
. . . . . THE FOUR STROKES OF THE PISTON



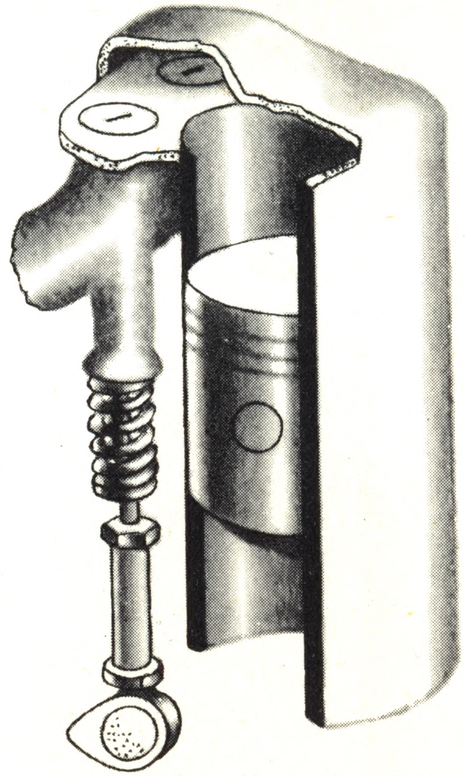


This is the fourth stroke, called the *Exhaust Stroke*, and the piston is ready to start all over again, sucking in more gas. A heavy wheel goes on spinning when it is once started, so a large fly-wheel made of heavy metal is fixed to the end of the crank shaft. This keeps the crank shaft turning round between the explosions. The crank shaft and fly-wheel have to spin round twice between each explosion, once for the explosion and exhaust, and once to suck in the gas and compress it. A motor car engine seldom has less than four cylinders, and the explosions happen so quickly after each other . . . thousands of times a minute, that the fly-wheel and crank shaft seem to go round quite smoothly. The up and down movement of the piston is turned into the round and round motion of the fly-wheel rather like your leg working the wheels of your bicycle. The connecting rod doing the same job as your leg.

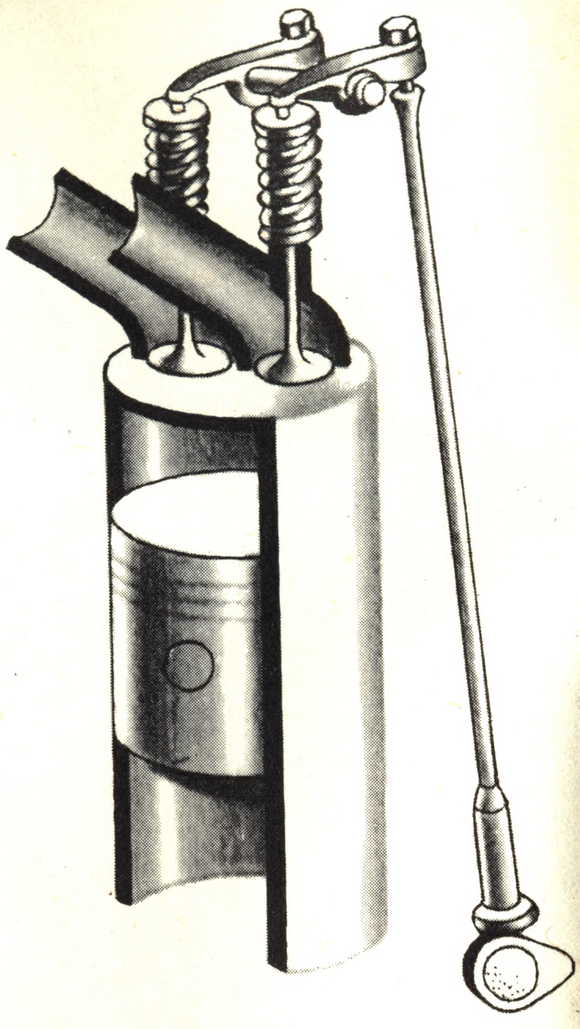
Valves and the Cams that work them



The valves are very important. They must open and shut the inlet and exhaust pipes at exactly the right moment. To open a valve a cam pushes up the valve stem. A spring shuts it. The cams are pear-shaped pieces of metal sticking out of a shaft, called the cam shaft. As this shaft revolves, the point of the cam comes to the top to open a valve once each time it goes completely round.



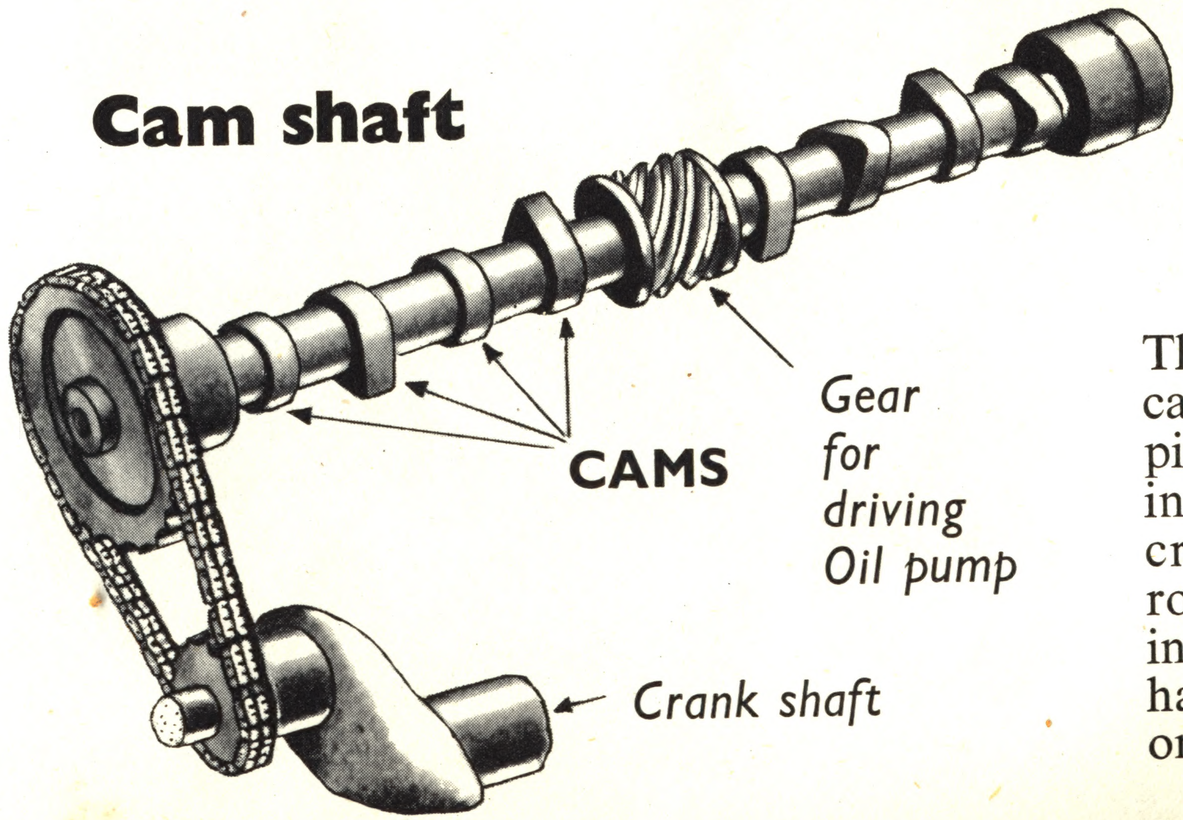
Side valves



Overhead valves

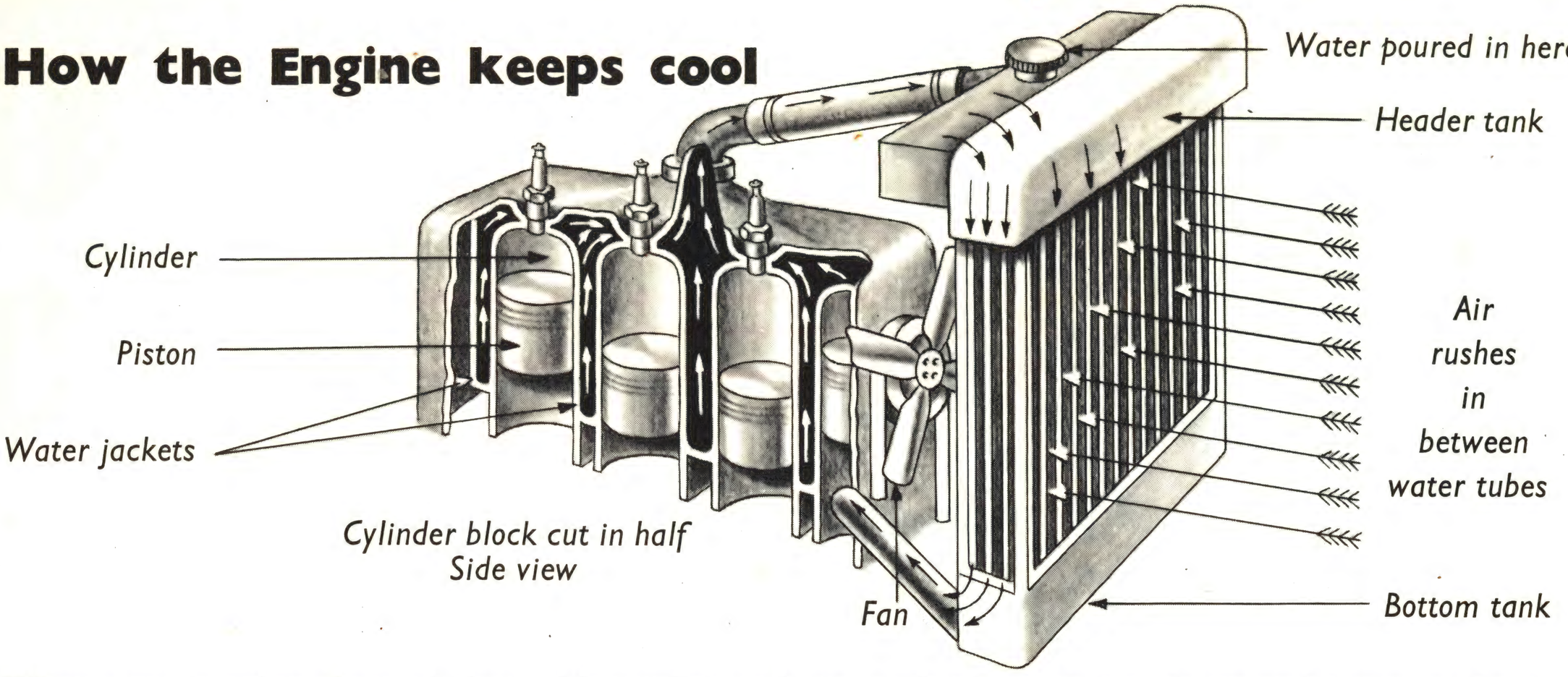
TIMING GEAR

The crank shaft works the cam shaft by gear wheels and a chain called the *Timing Gear*. This makes the cam shaft spin round once while the crank shaft goes round twice.

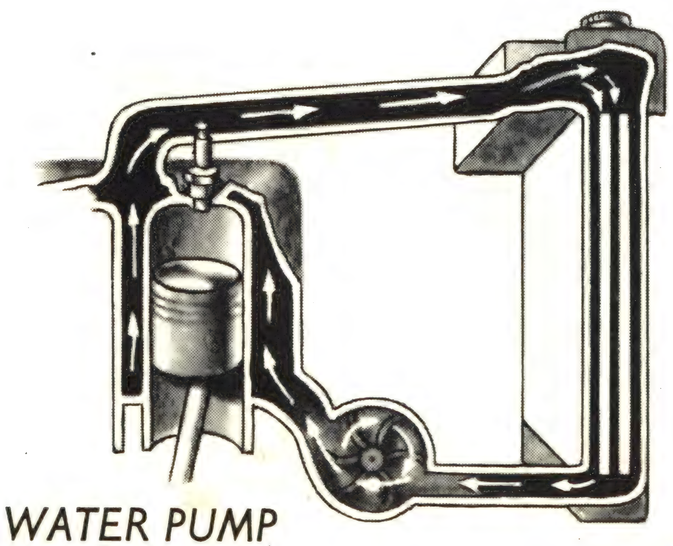


This happens because during each piston's four strokes in its cylinder, the crank shaft goes round twice, but the inlet valve and exhaust valve open only once each.

How the Engine keeps cool

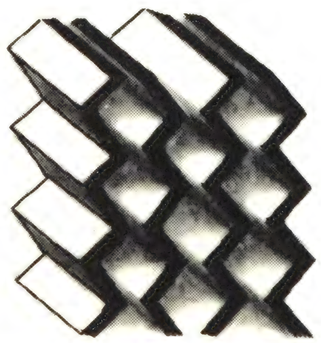


When a car is going along at about thirty miles an hour, each piston may slide up and down inside its cylinder six thousand times a minute. The heat in the middle of the explosion is about ten times hotter than boiling point. Something must be done to cool the cylinders. They are surrounded by water. This is poured into the top of the radiator. It runs round the cylinders helped by a pump and back to the radiator, where it is cooled by the cold air which rushes in between the thin tubes of the radiator, and this is helped by a fan. All these metal surfaces that rub together and slide against each other would get very hot and wear away very quickly if they were not protected by a film of oil which keeps the metal surfaces apart. That is why it is so important to have enough oil in the sump.



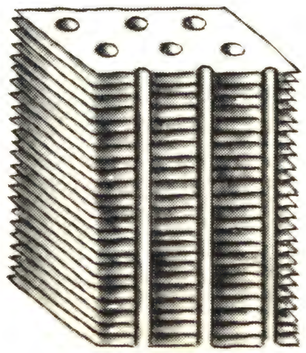
WATER PUMP

HONEYCOMB

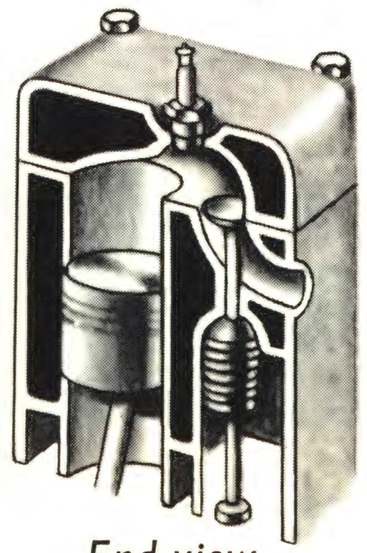


Best but more expensive

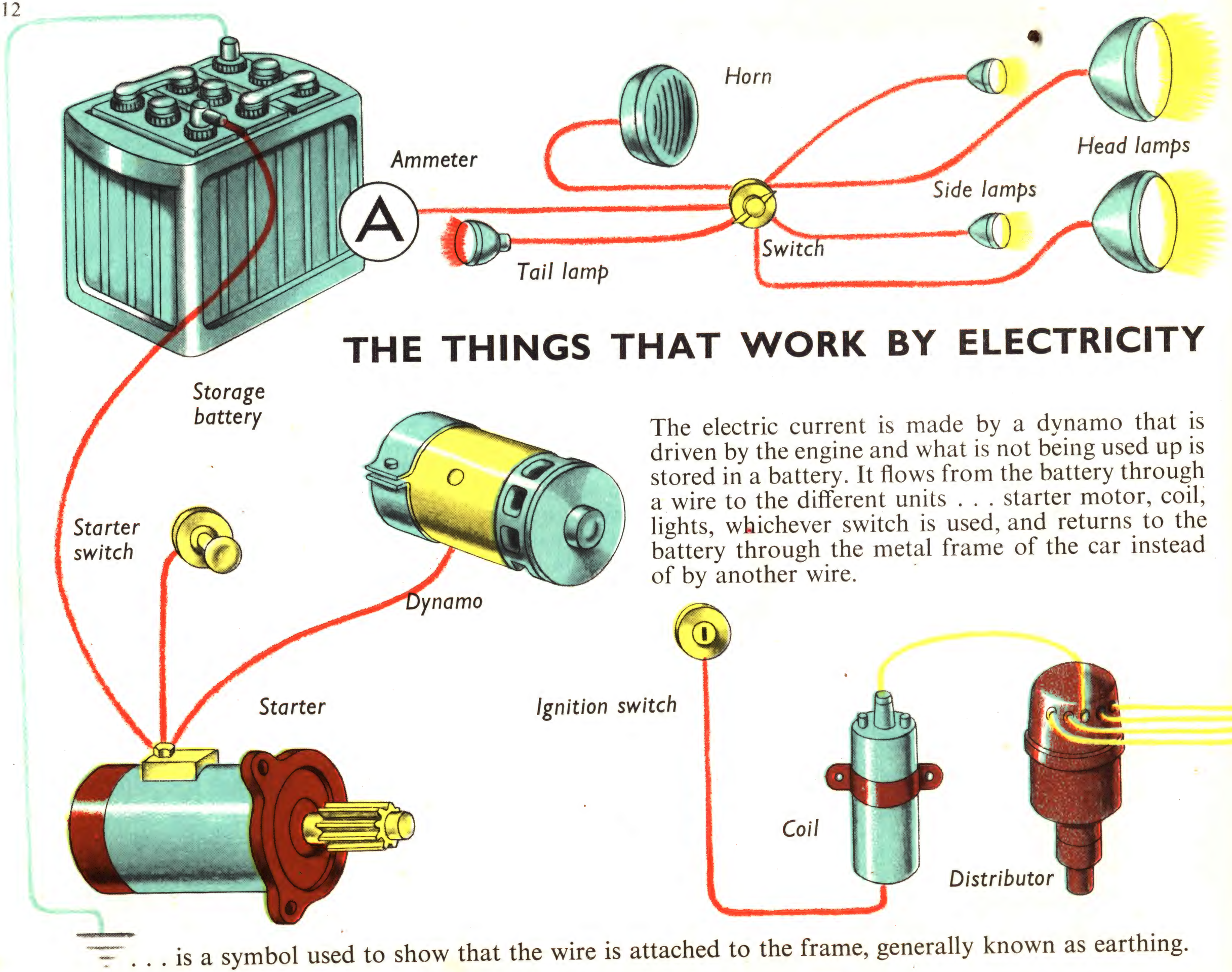
WATER TUBE



Fins made of copper



End view



THE THINGS THAT WORK BY ELECTRICITY

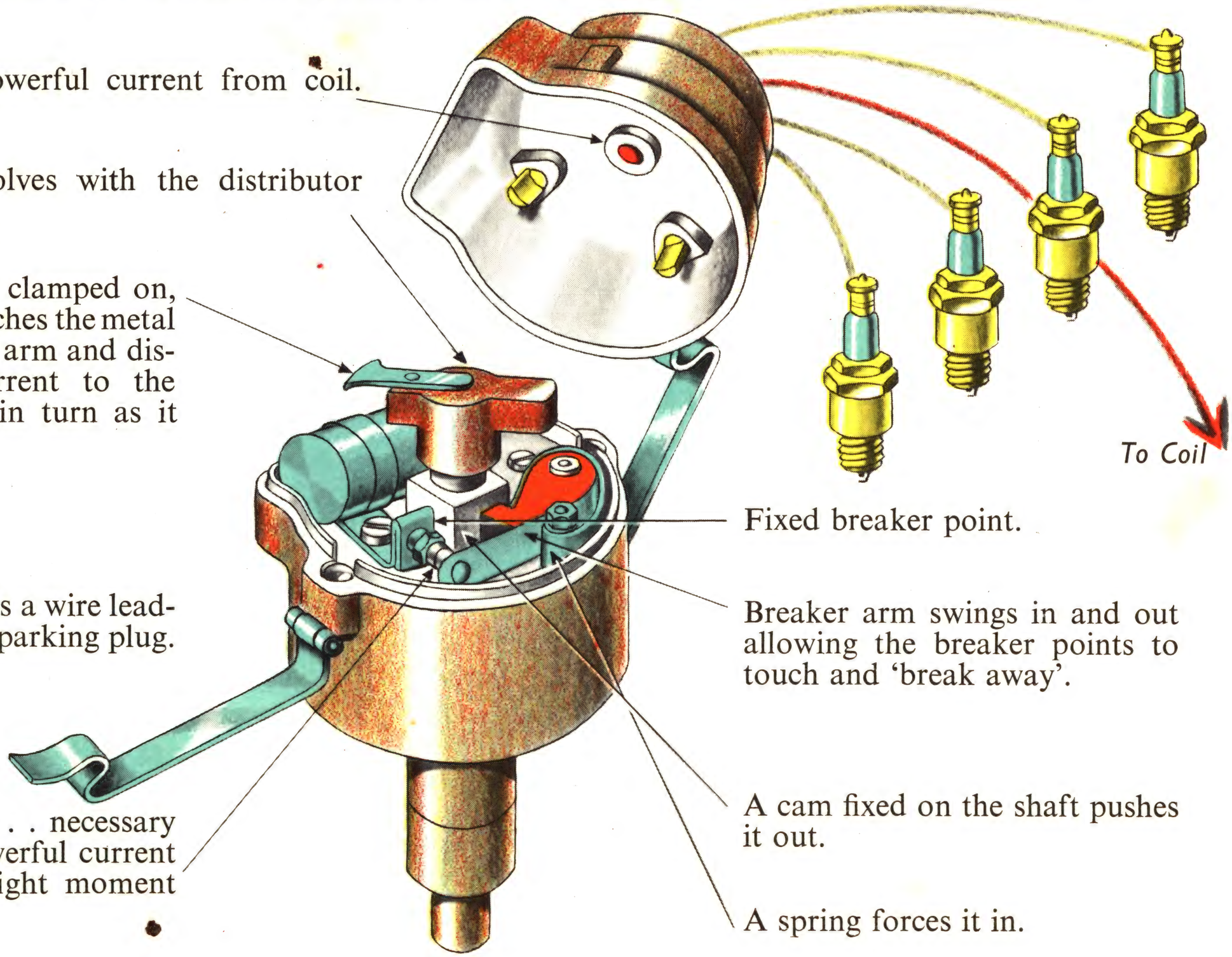
The electric current is made by a dynamo that is driven by the engine and what is not being used up is stored in a battery. It flows from the battery through a wire to the different units . . . starter motor, coil, lights, whichever switch is used, and returns to the battery through the metal frame of the car instead of by another wire.

. . . is a symbol used to show that the wire is attached to the frame, generally known as earthing.

THE DISTRIBUTOR THAT CONTROLS THE SPARK

To make a spark a more powerful electric current is needed than the one supplied by the battery.

The current from the battery flows through the coil, where it is made two thousand times more powerful. It is then sent on to each sparking plug in turn by the distributor. When it reaches the plug it jumps across a gap between two points at the end of the plug, making a spark.



Terminal for powerful current from coil.

Rotor arm revolves with the distributor shaft.

When the cap is clamped on, this terminal touches the metal part of the rotor arm and distributes the current to the other terminals in turn as it goes round.

Each terminal has a wire leading from it to a sparking plug.

Breaker points . . . necessary to make the powerful current at exactly the right moment for the sparks.

Fixed breaker point.

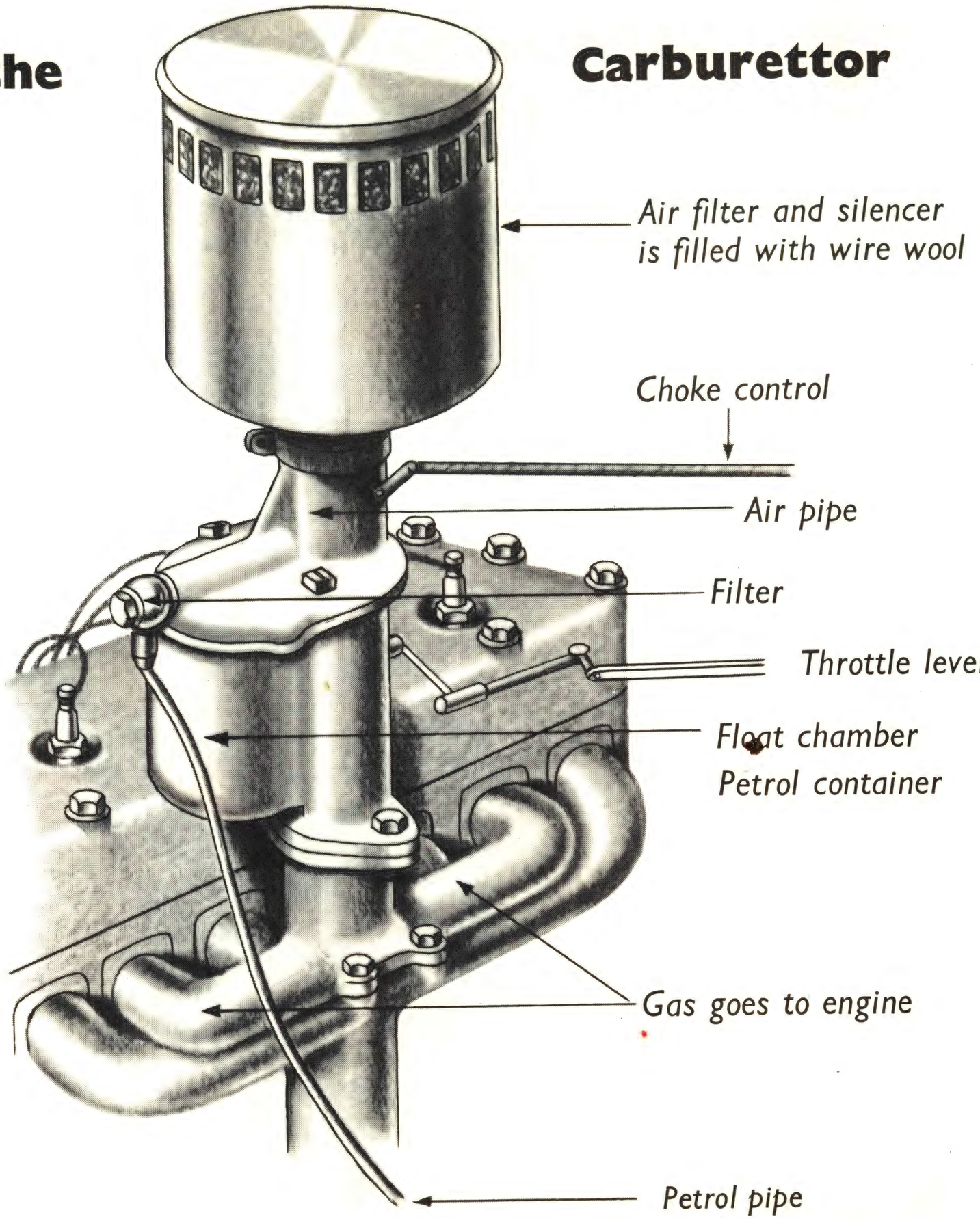
Breaker arm swings in and out allowing the breaker points to touch and 'break away'.

A cam fixed on the shaft pushes it out.

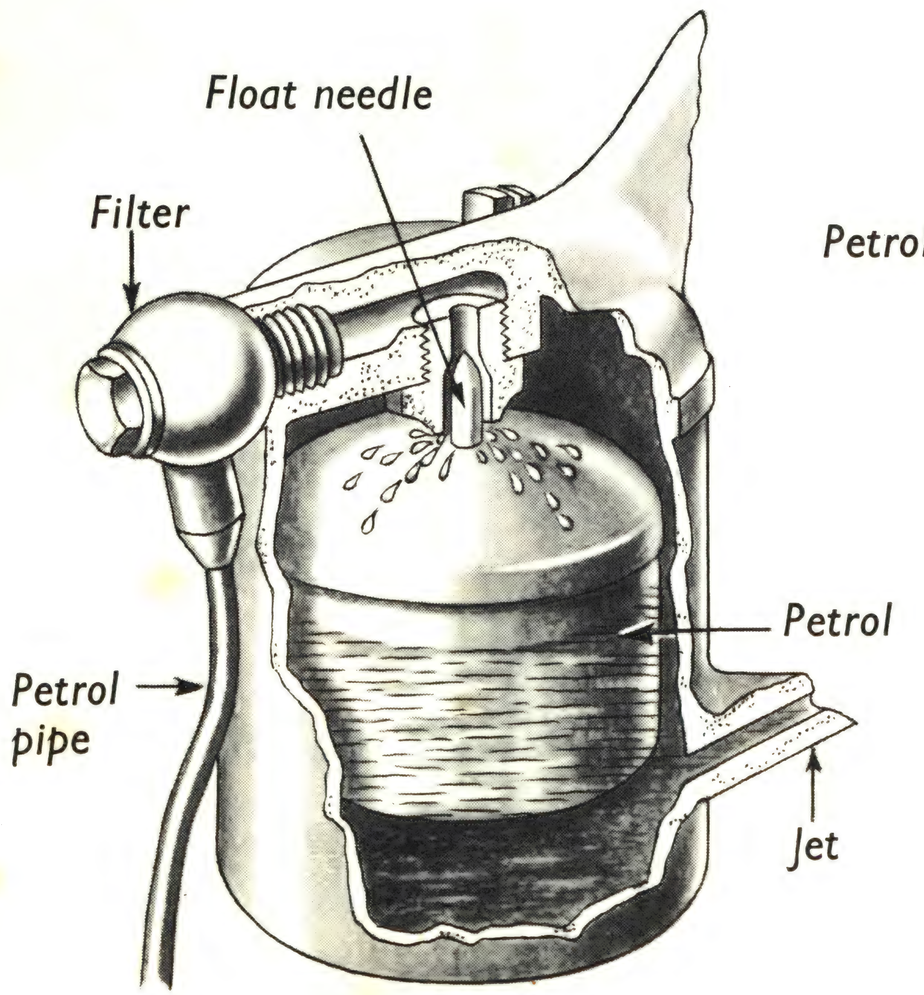
A spring forces it in.

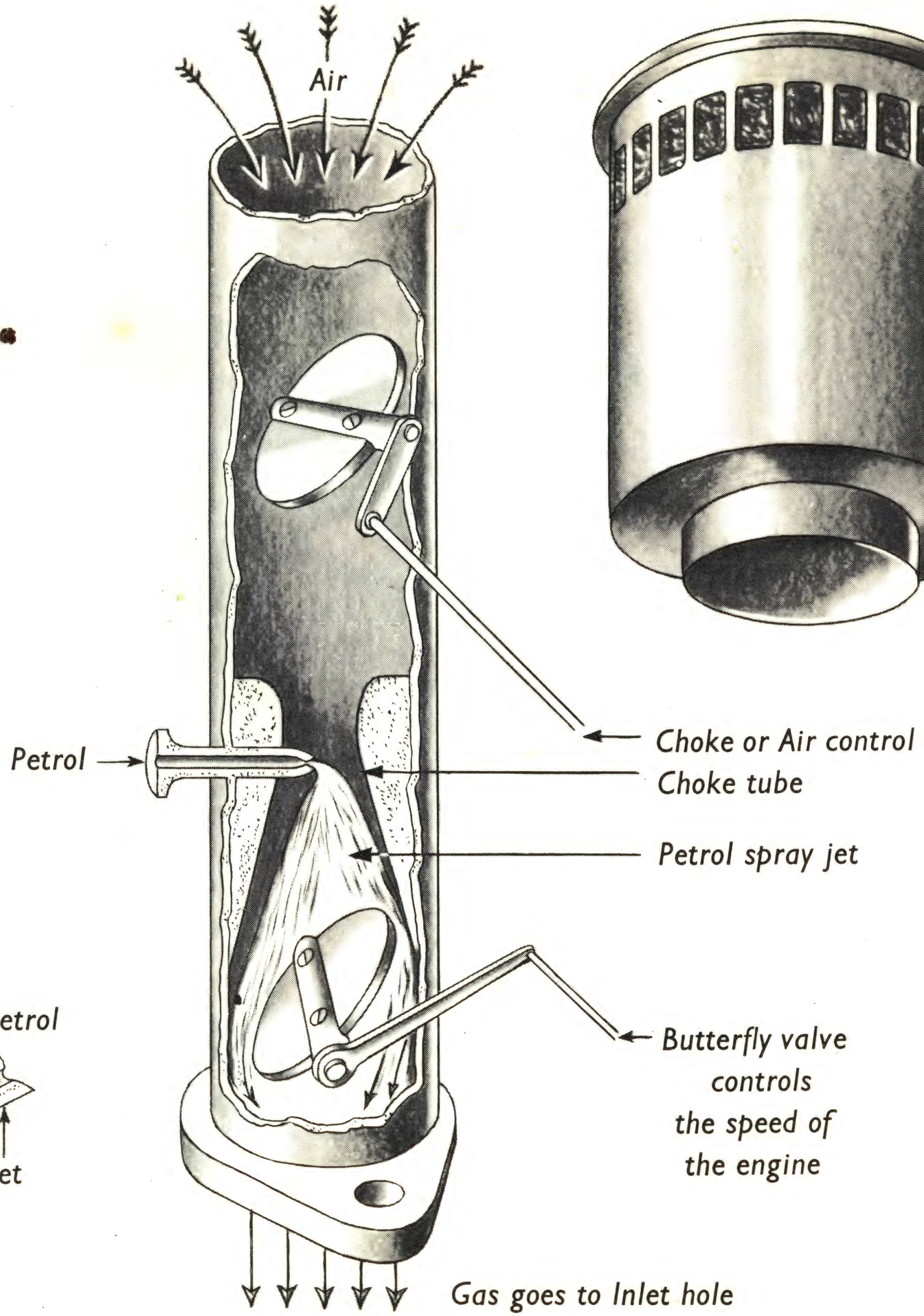
This is the Carburettor

The carburettor has two jobs to do. It must turn petrol into vapour and then mix it with the right amount of air to make the explosive gas for the engine. Air is sucked into the air pipe; the amount can be varied by the choke control. It rushes past a fine jet that is spraying out petrol. This petrol spray and air mixed together are sucked into the cylinders, through the inlet valves. How much flows into the cylinders is regulated by a butterfly valve worked by the accelerator pedal.

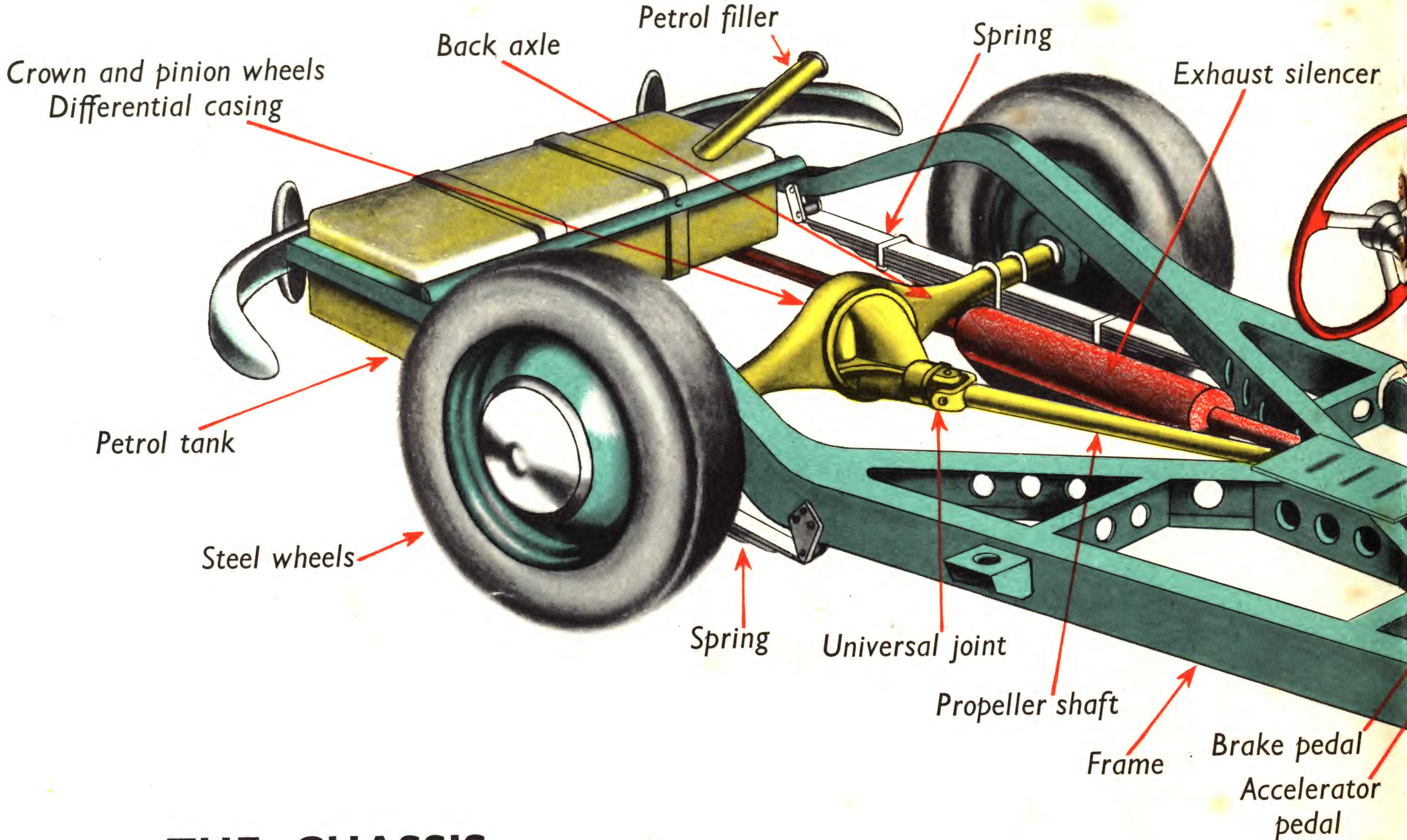


The flow of petrol to the jet is regulated by a float in the petrol container. This rises and falls with the level of the petrol. When the container is full the float rises and stops up the petrol pipe with a needle.

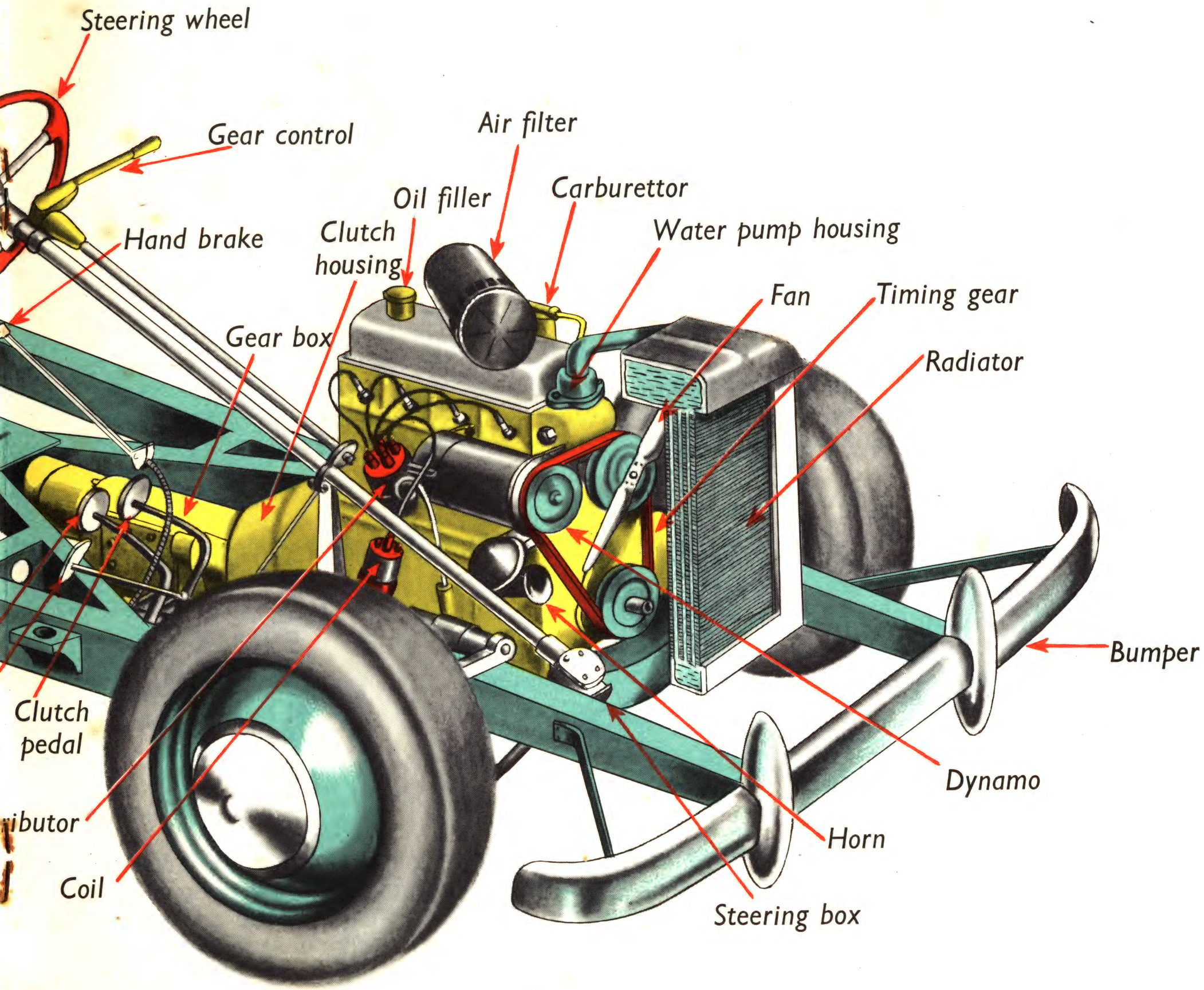




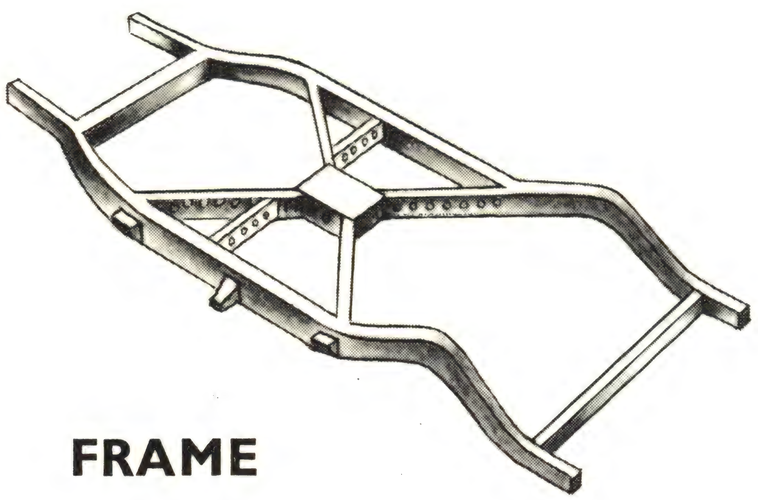




THE CHASSIS
IS THE STEEL FRAMEWORK OF THE CAR


Steering wheel
Gear control
Air filter
Oil filler
Carburettor
Hand brake
Clutch housing
Water pump housing
Fan
Timing gear
Gear box
Radiator
Bumper
Clutch pedal
Dynamo
ibutor
Horn
Coil
Steering box

The important parts that make a motor car



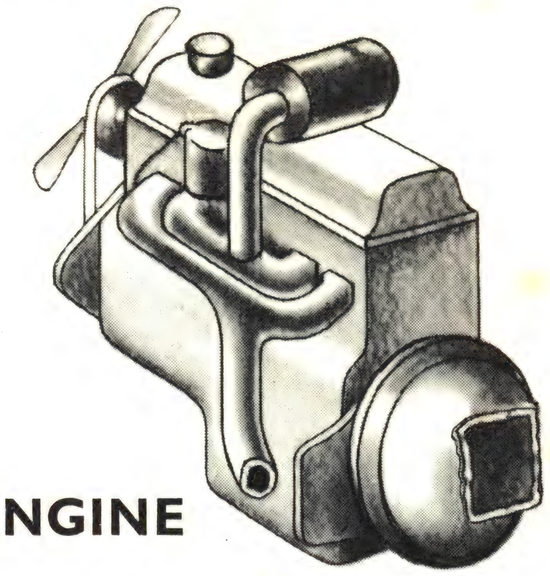
FRAME

The frame is made of two long pieces of steel held together by cross bars. The car is built on this frame, so it must be very strong.



BODY

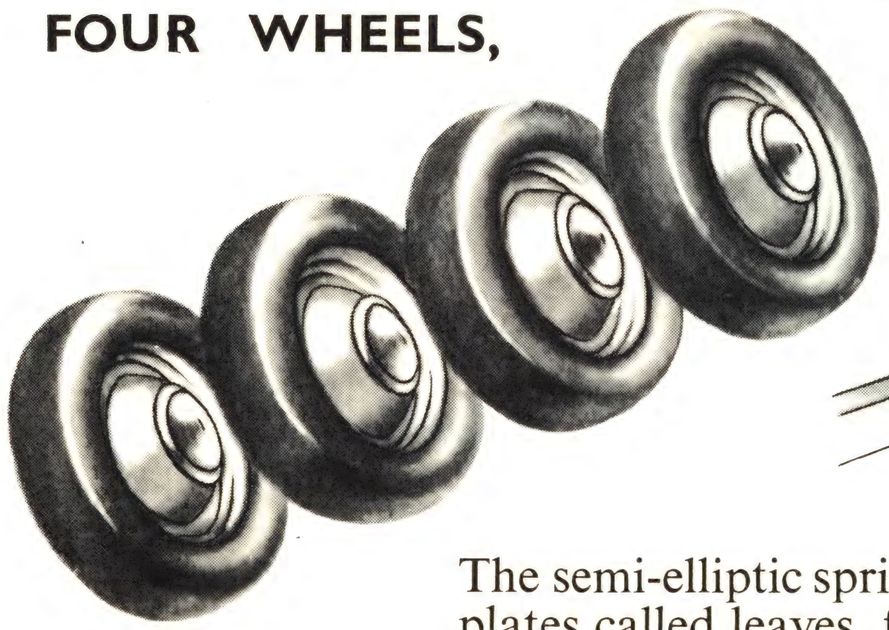
The body is fixed on to this steel frame. It is like a small room. It has walls, usually made of metal, with doors, windows, and a roof.



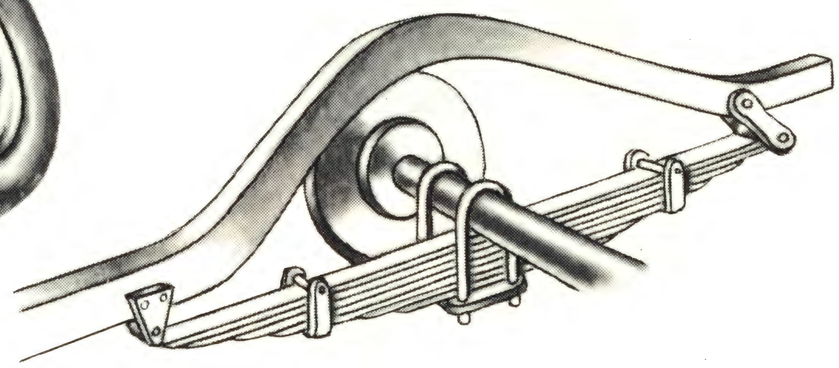
ENGINE

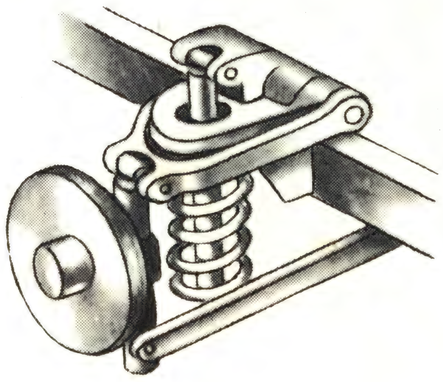
The engine, which is fixed to the frame, is very heavy and is able to pull the whole weight of the car and its passengers along.

FOUR WHEELS,

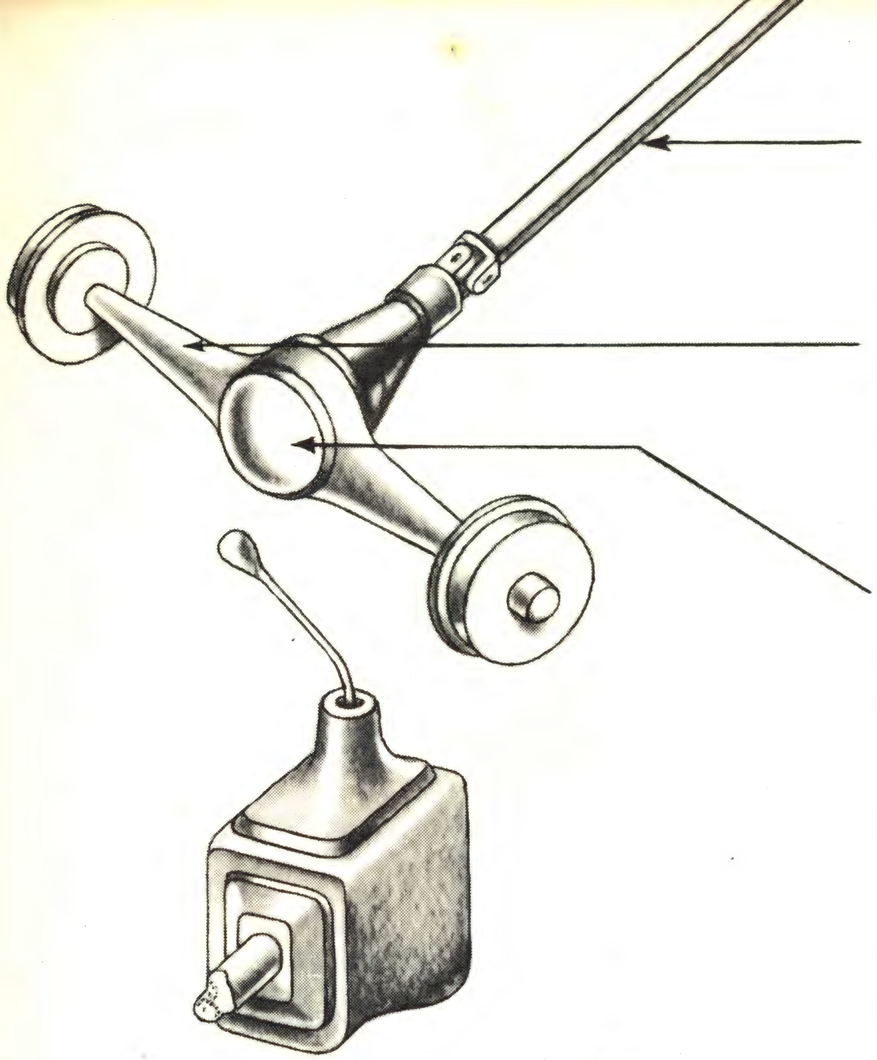


FIRMLY FIXED TO FRAME BY SPRINGS





The semi-elliptic spring usually used for the rear wheels is made up of several thin steel plates called leaves, fastened together by a bolt in the centre and two clips, one either side of the bolt. The two ends of the spring are fixed to the frame of the car and the centre is bolted to the axle. The front two wheels often have independent spiral springs.



PROPELLER SHAFT

takes the power from the engine to the back wheels. It has a universal joint at each end.

BACK AXLE

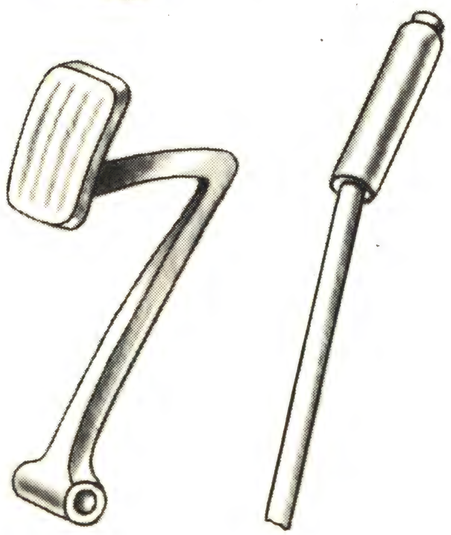
is in two halves joined in the centre by a set of cog wheels. Two of these make the propeller shaft turn the back wheels.

DIFFERENTIAL

is the name of the other cog wheels that allow one wheel to turn faster than the other at corners.

GEAR BOX

A box filled with cog wheels of different sizes arranged with relation to one another. Used for starting, climbing hills, going fast along a flat road and making the car go backwards.



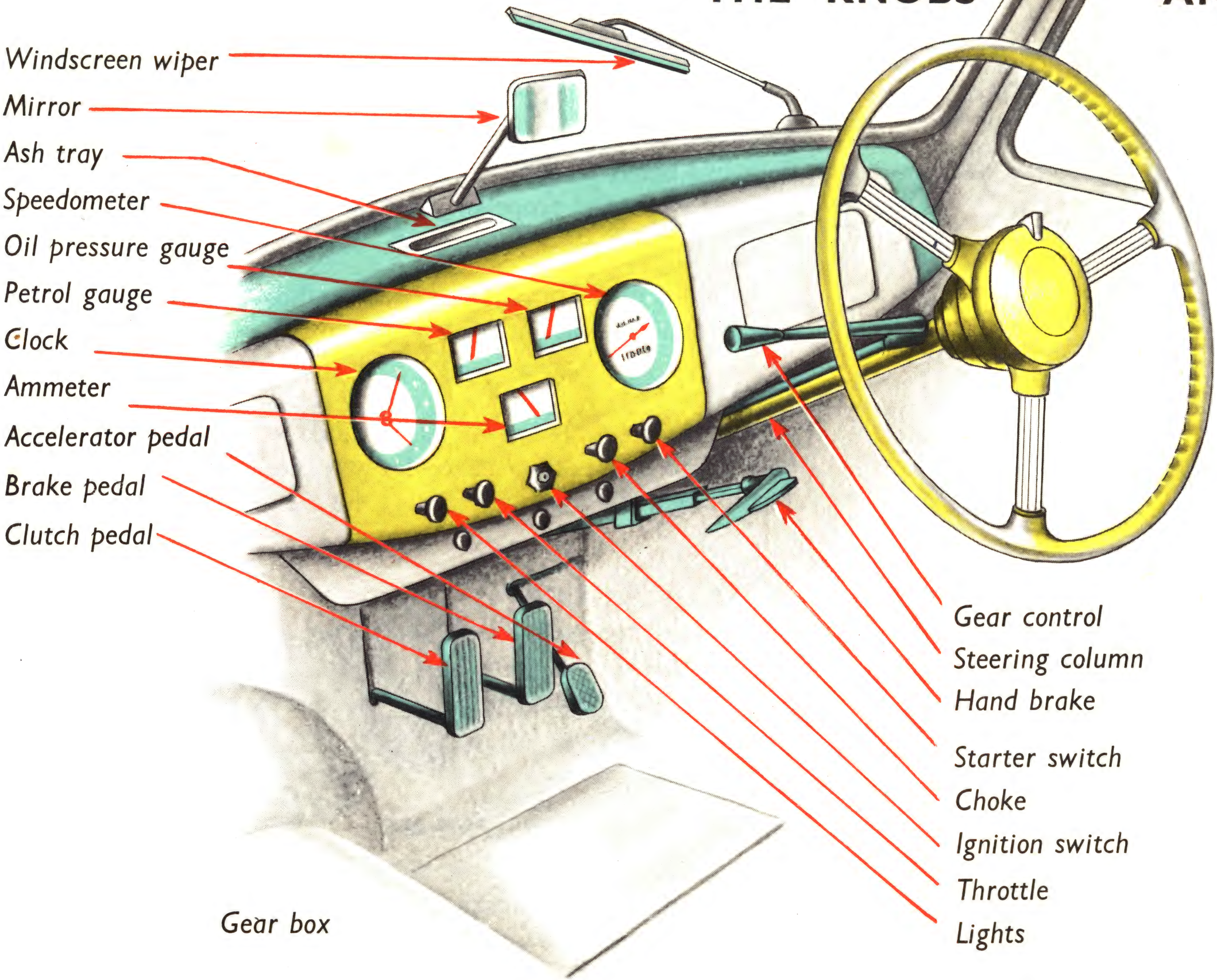
BRAKES

There is one for each wheel and they are worked by a foot pedal. A hand lever works the brakes generally on the two rear wheels and operates independently from the foot pedal. The hand brake is used for parking.

ELECTRICAL EQUIPMENT

The starter motor, sparking plugs, lights, horn, and sometimes other gadgets, all need electricity. This is made by a dynamo and is stored in a battery.

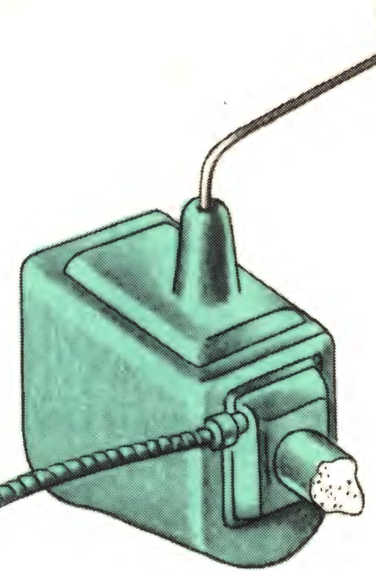
THE KNOBS AND



The gear control can be either on the steering column or a stick coming directly from the gear box.

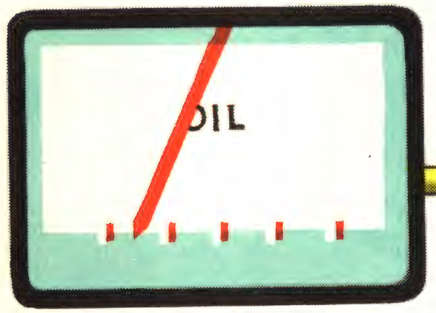
DIALS ON THE DASHBOARD





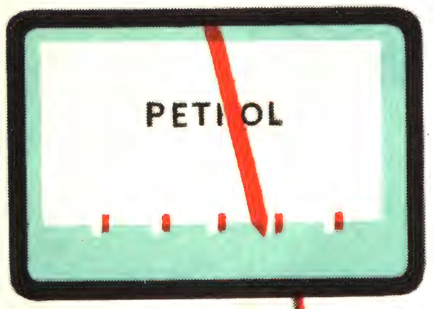
SPEEDOMETER — MILEOMETER

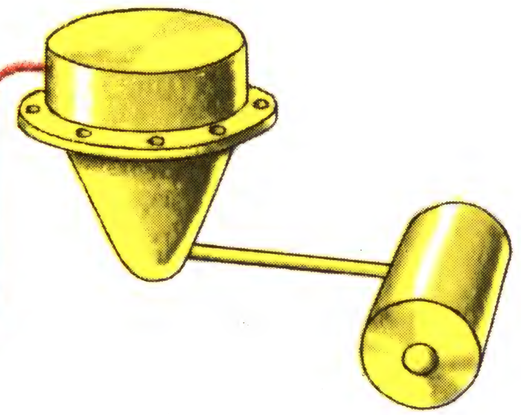
shows by a hand like a clock hand how fast the car is going. It has a special mark to show the thirty-mile-an-hour speed limit. It can be driven from the gear box. It also records how many miles the car has travelled.



OIL PRESSURE GAUGE

shows the pressure at which the oil is being pumped round the engine.





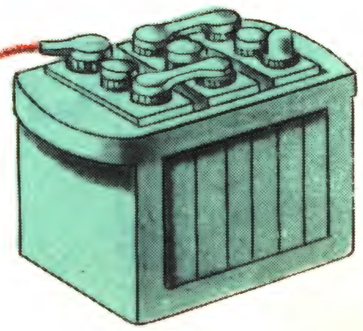
PETROL GAUGE

shows how much petrol there is in the tank at the back of the car. It is often worked by a float and an electrical unit in the tank.

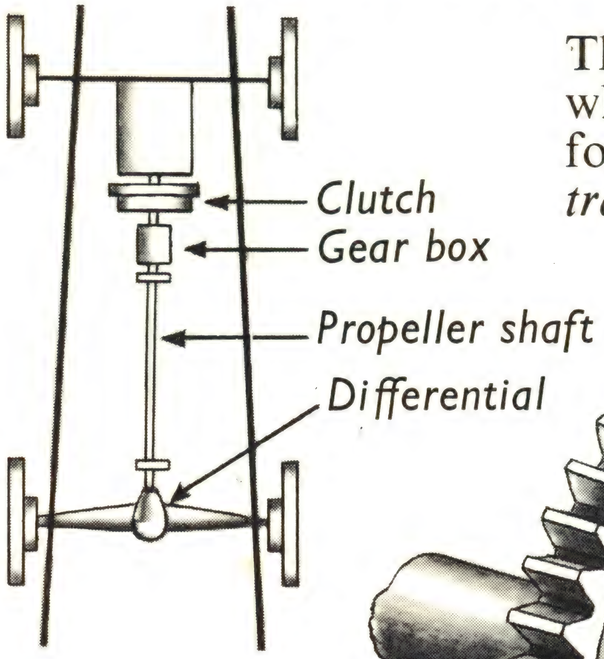


AMMETER

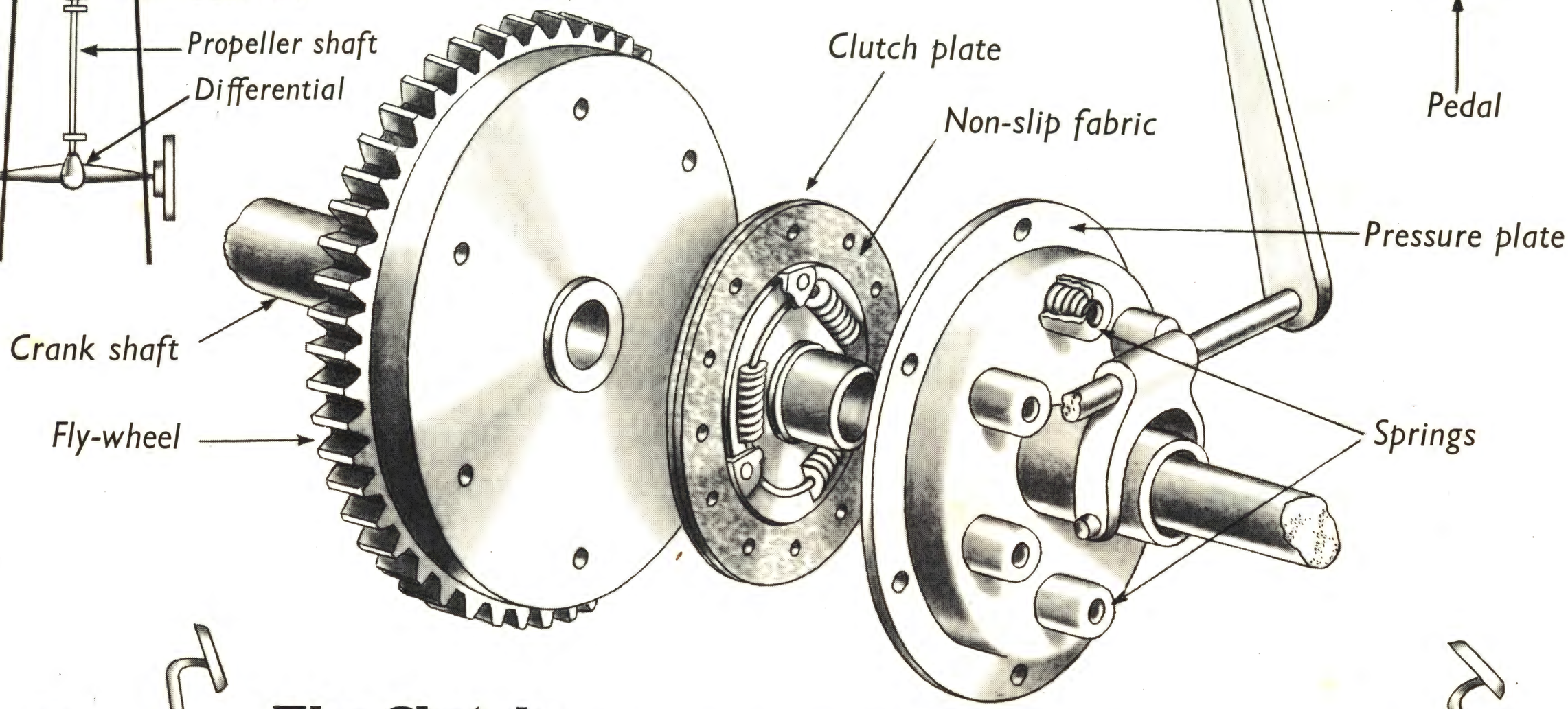
shows the amount of electricity that is going into or coming out of the storage battery.

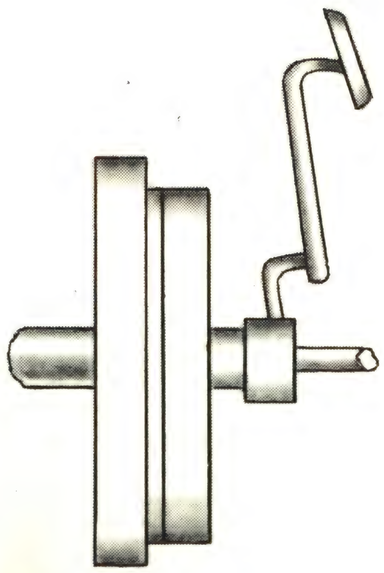


The Story of the Transmission System



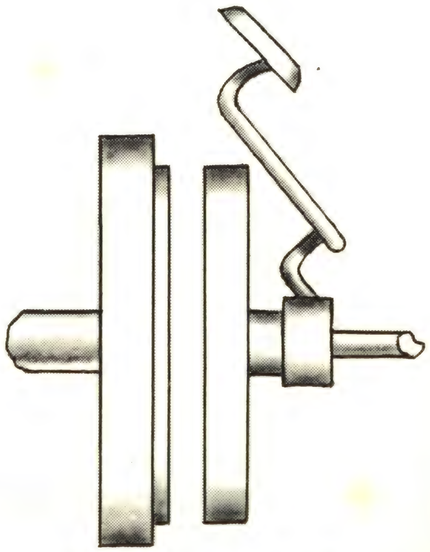
The power from the engine has to get to the back wheels of the car. This is not a simple job. There are four main parts that do it, and they are called the *transmission system*.





CLUTCH IN

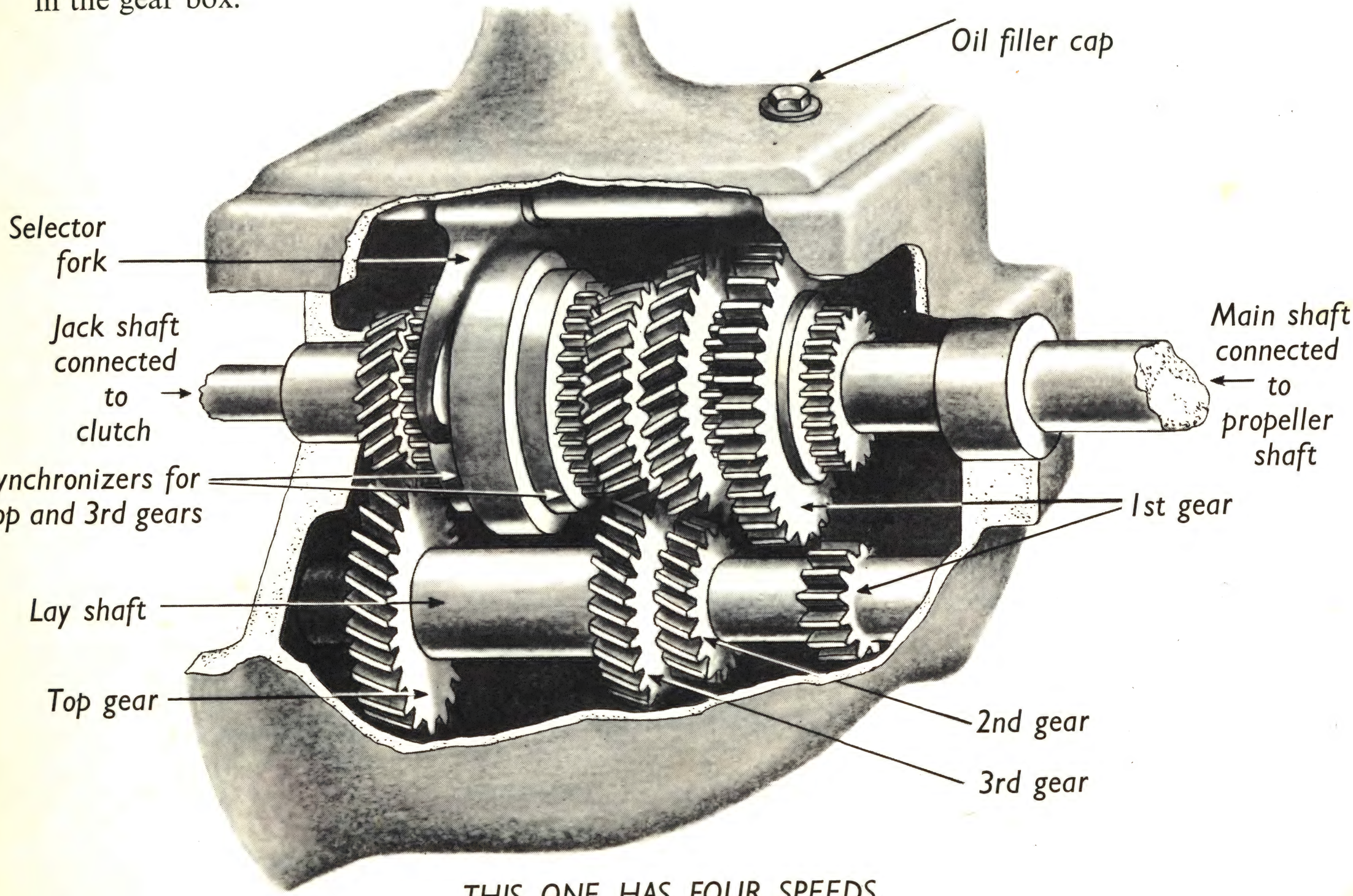
The Clutch links up or separates the power from the engine to the main driving shaft that turns the back wheels. It consists of the fly-wheel on the engine crank shaft, the clutch plate with its rings of non-slip fabric, and the pressure plate on the main shaft that goes to the gear box. These three are held tightly together by strong springs and all spin round at the same time. They are enclosed in a metal casing bolted to the crank case. When the clutch pedal is pressed down, these plates separate and there is no connection between the fly-wheel and the main driving shaft.



CLUTCH OUT

The Gear Box

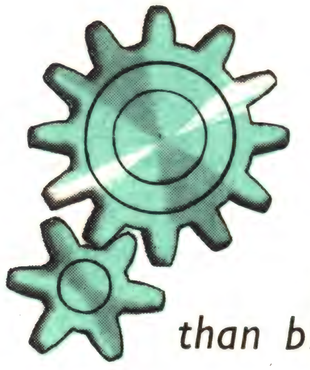
A car is a very heavy weight for the engine to pull along; it can only do it with the help of the gear box. On a flat road the engine is linked directly to the back wheels, but for starting off and climbing hills, the back wheels need more power. This is obtained by using the sets of cog wheels in the gear box.



THIS ONE HAS FOUR SPEEDS

HOW THE GEARS WORK

These are the gear wheels that do the work. All the others are used to make the gear changes easier. The ones with slanting teeth are called helical gears; they slide into gear more smoothly than straight ones. First gear has straight teeth.



Small wheel spins round faster than big one

It must spin round twice while the big one goes round once

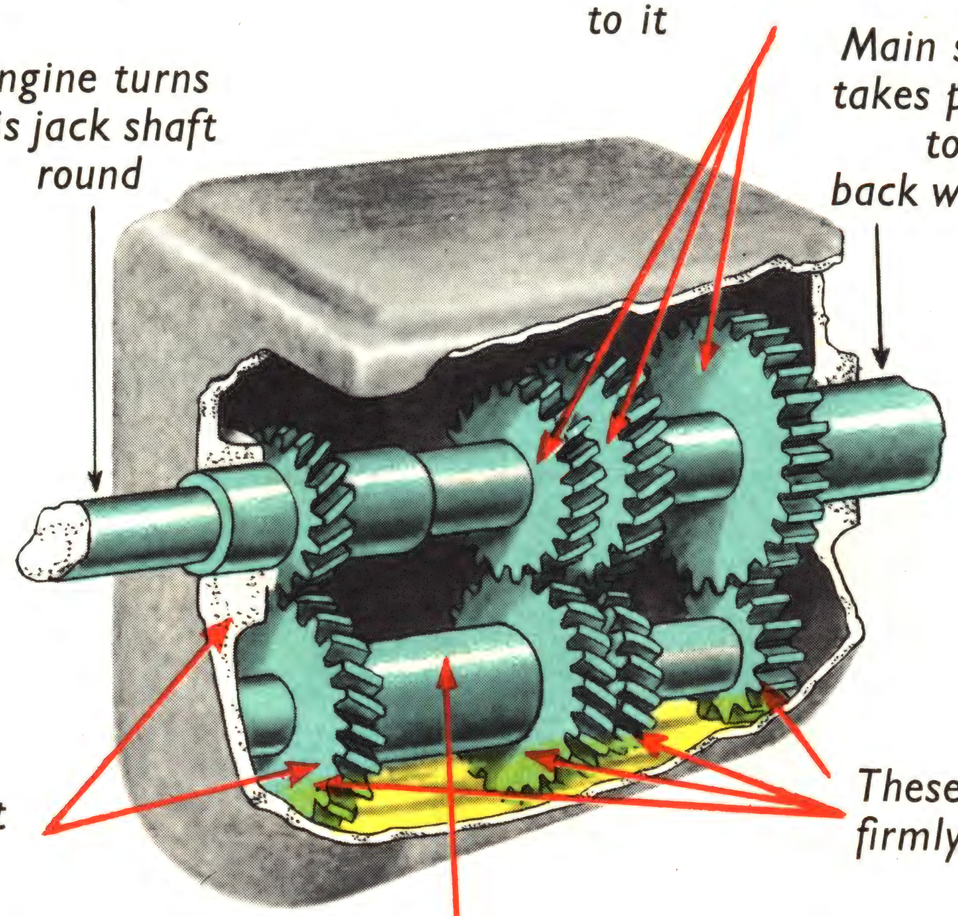
The big one goes twice as slowly but is twice as powerful

Helical gears are used for 2nd, 3rd, and top

Each of these wheels is free to revolve on the shaft but can be locked to it

Engine turns this jack shaft round

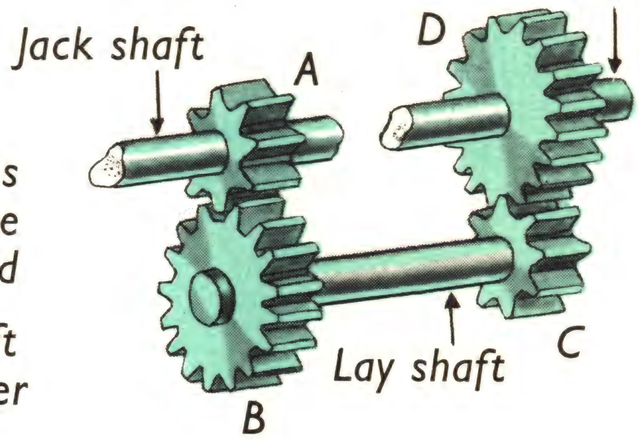
Main shaft takes power to back wheels



Constant mesh gears

These gear wheels are firmly fixed to shaft

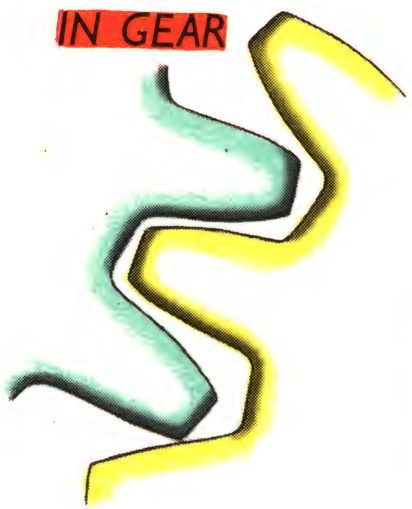
Lay shaft revolves all the time the engine is running

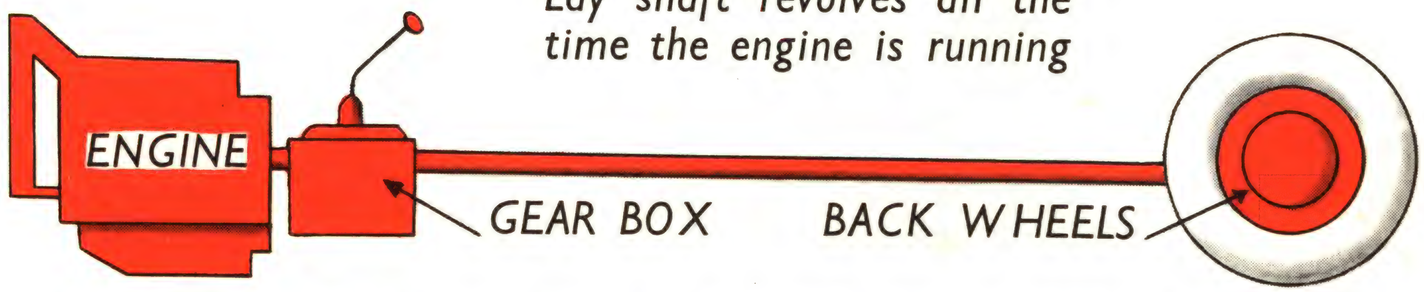


B two times slower than A

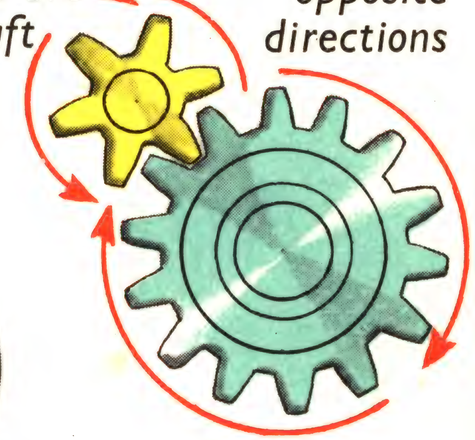
D two times slower than C

So D goes round four times slower than A but has four times the power





Turn round in opposite directions

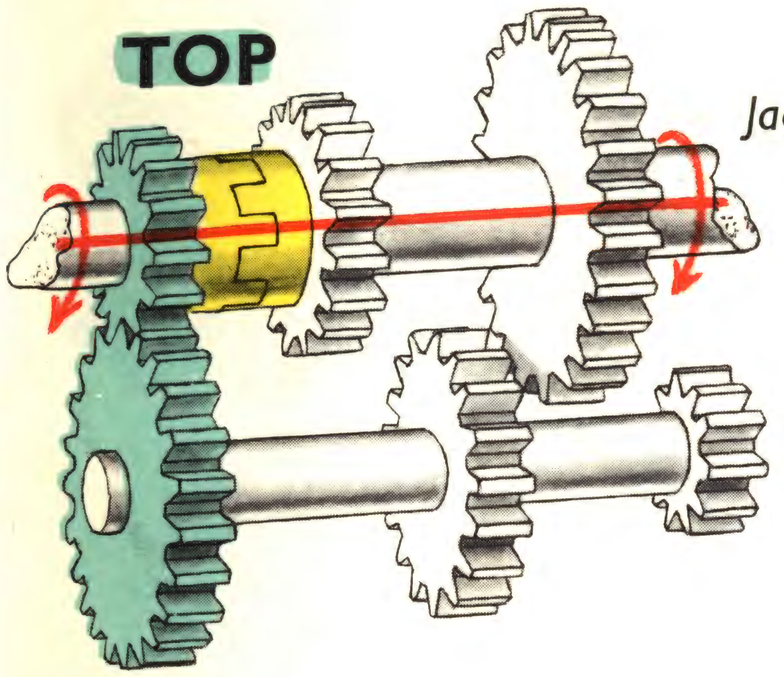


The gear wheels in the gear box change the speed and power of the back wheels.

AND HOW THEY CHANGE THE SPEED

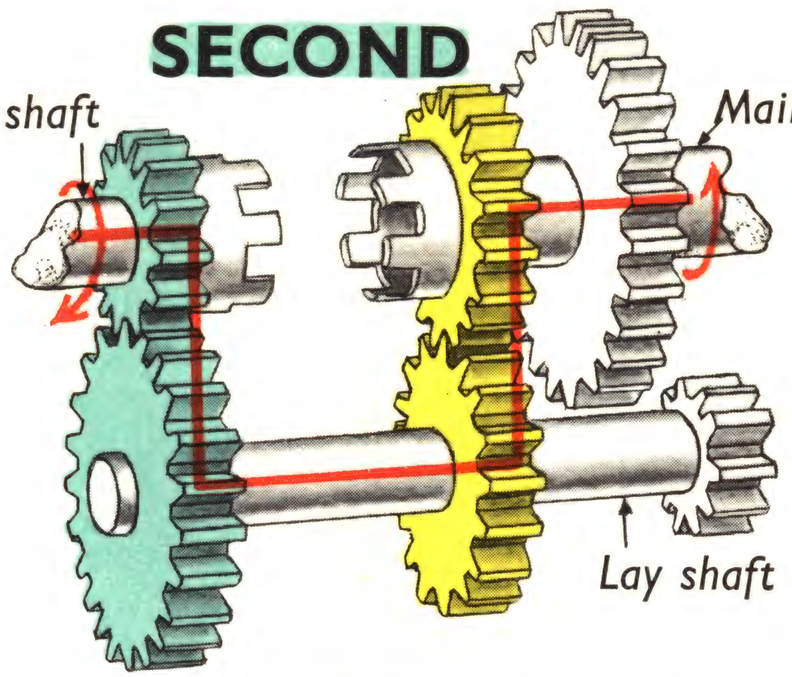
Sometimes a car has four forward speeds. This one has three and reverse.

TOP



Jack shaft and main shaft join up. Gear wheels on lay shaft revolve but are not used.

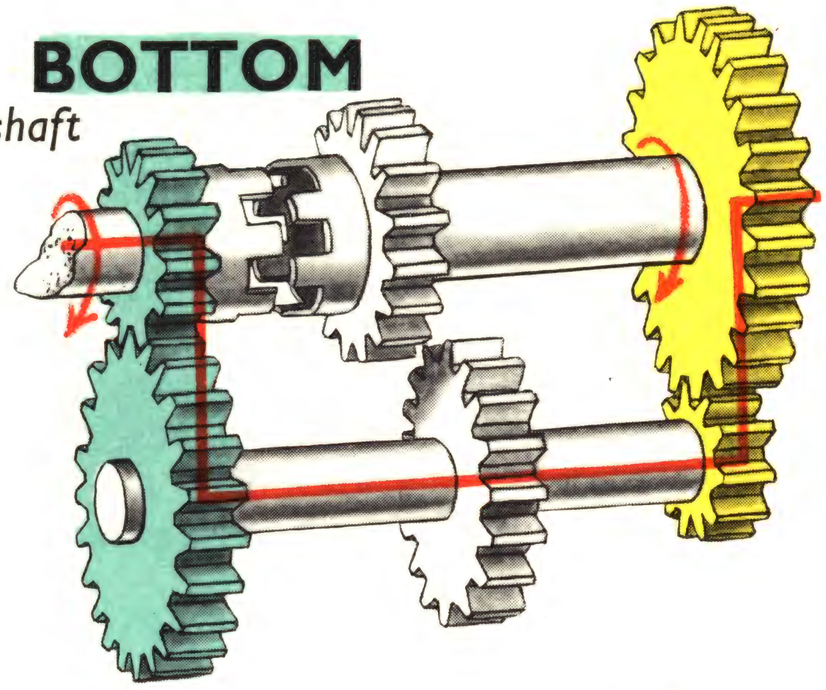
SECOND



Gear wheel on main shaft is in gear with one on lay shaft.

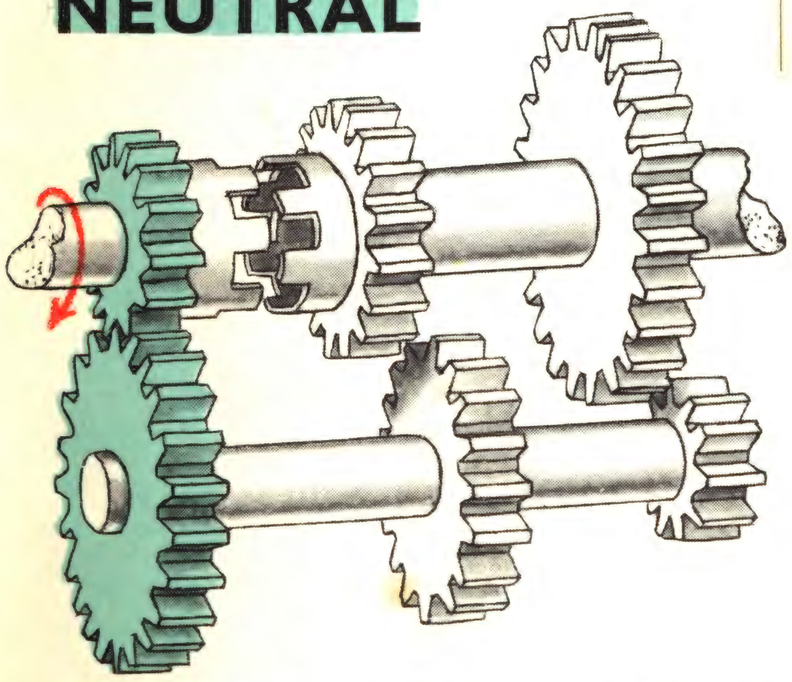
SECOND GEAR CHANGE (*above*)
The red direction arrow on the main shaft should point downwards

BOTTOM



Big gear wheel on main shaft is in gear with small one on lay shaft.

NEUTRAL



There is no connection at all between jack shaft and main shaft.

TOP GEAR, for going along a flat road.

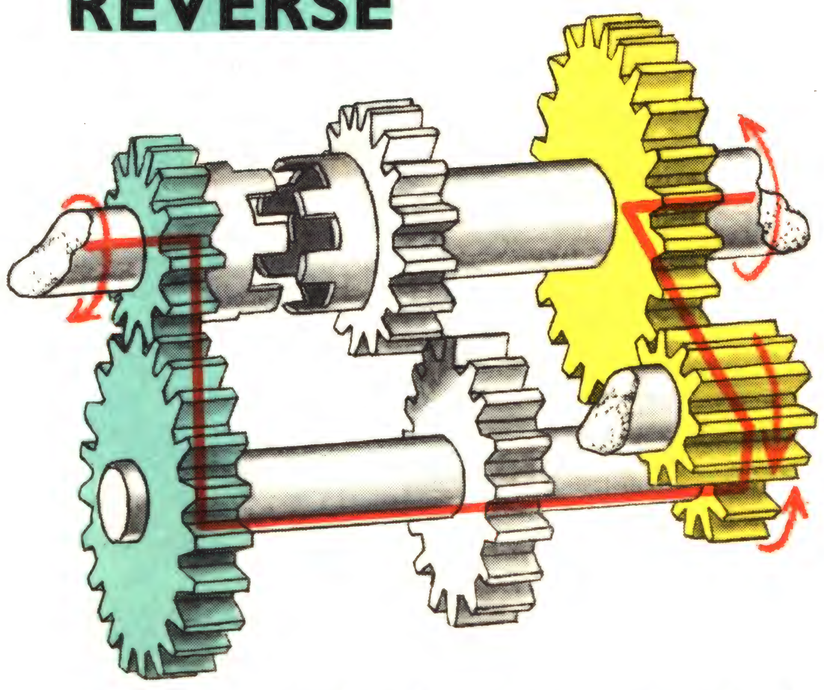
SECOND OR THIRD, for climbing hills.

BOTTOM, for starting and climbing very steep hills.

NEUTRAL, when the car is standing still.

REVERSE, when you want to go backwards.

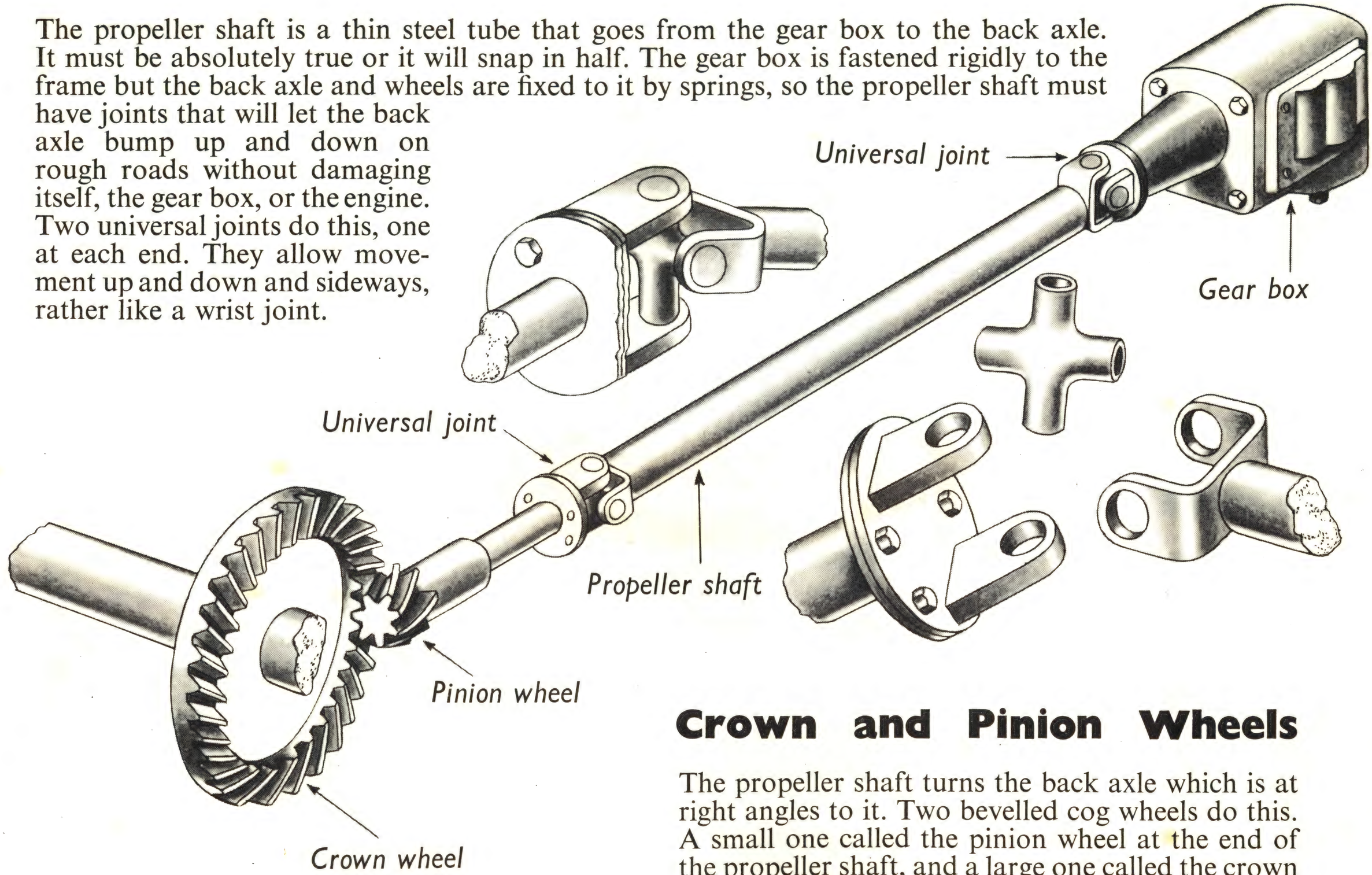
REVERSE



Extra gear wheel makes main shaft turn in opposite direction.

Propeller Shaft and its Universal Joints

The propeller shaft is a thin steel tube that goes from the gear box to the back axle. It must be absolutely true or it will snap in half. The gear box is fastened rigidly to the frame but the back axle and wheels are fixed to it by springs, so the propeller shaft must have joints that will let the back axle bump up and down on rough roads without damaging itself, the gear box, or the engine. Two universal joints do this, one at each end. They allow movement up and down and sideways, rather like a wrist joint.



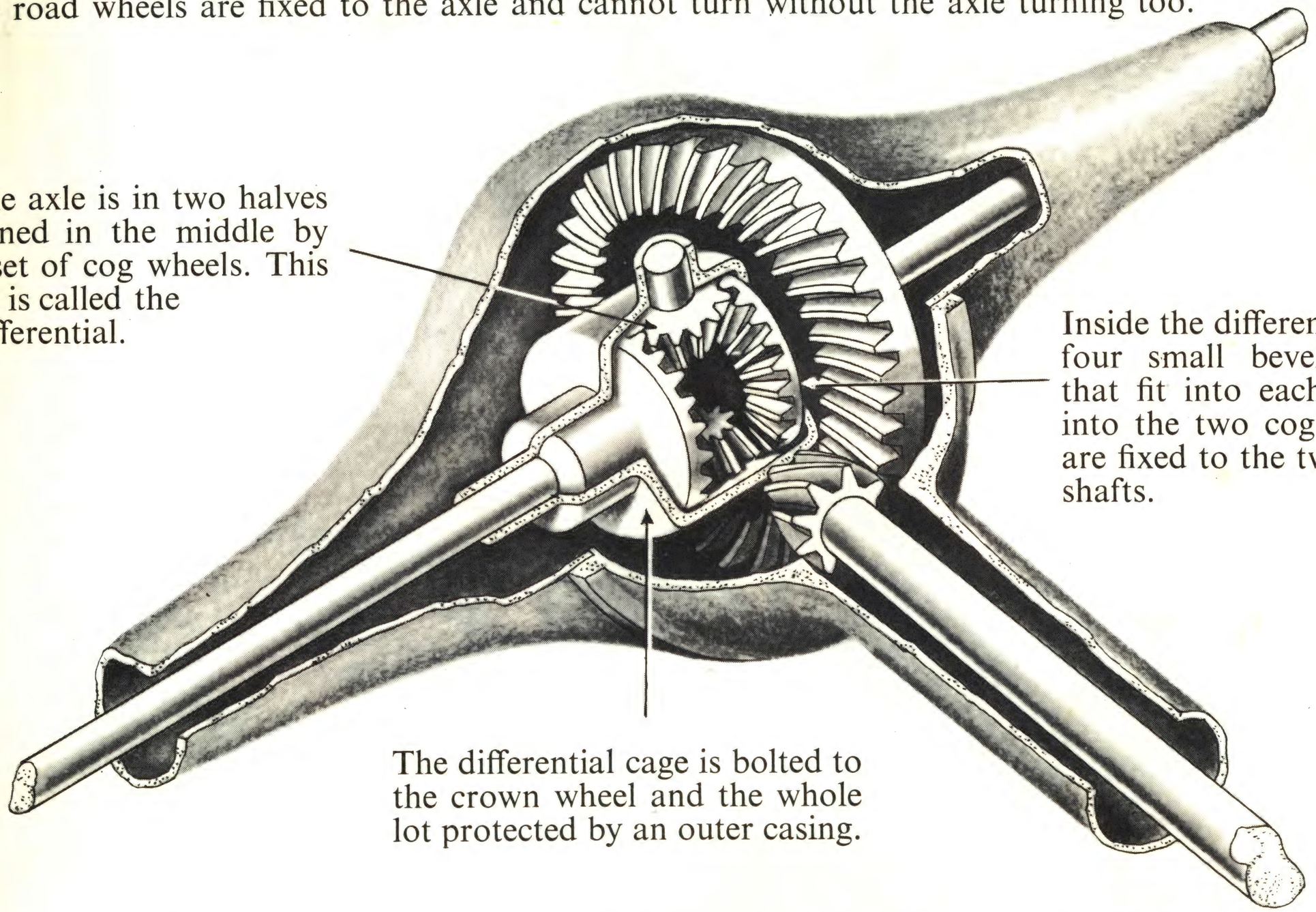
Crown and Pinion Wheels

The propeller shaft turns the back axle which is at right angles to it. Two bevelled cog wheels do this. A small one called the pinion wheel at the end of the propeller shaft, and a large one called the crown wheel on the back axle.

The Bulge in the Back Axle

The back axle is a very clever piece of machinery. It has a strong outer casing made of steel that takes the weight of the back of the car. It has a large bulge in the centre. Inside this casing is the real axle. The road wheels are fixed to the axle and cannot turn without the axle turning too.

The axle is in two halves joined in the middle by a set of cog wheels. This set is called the differential.

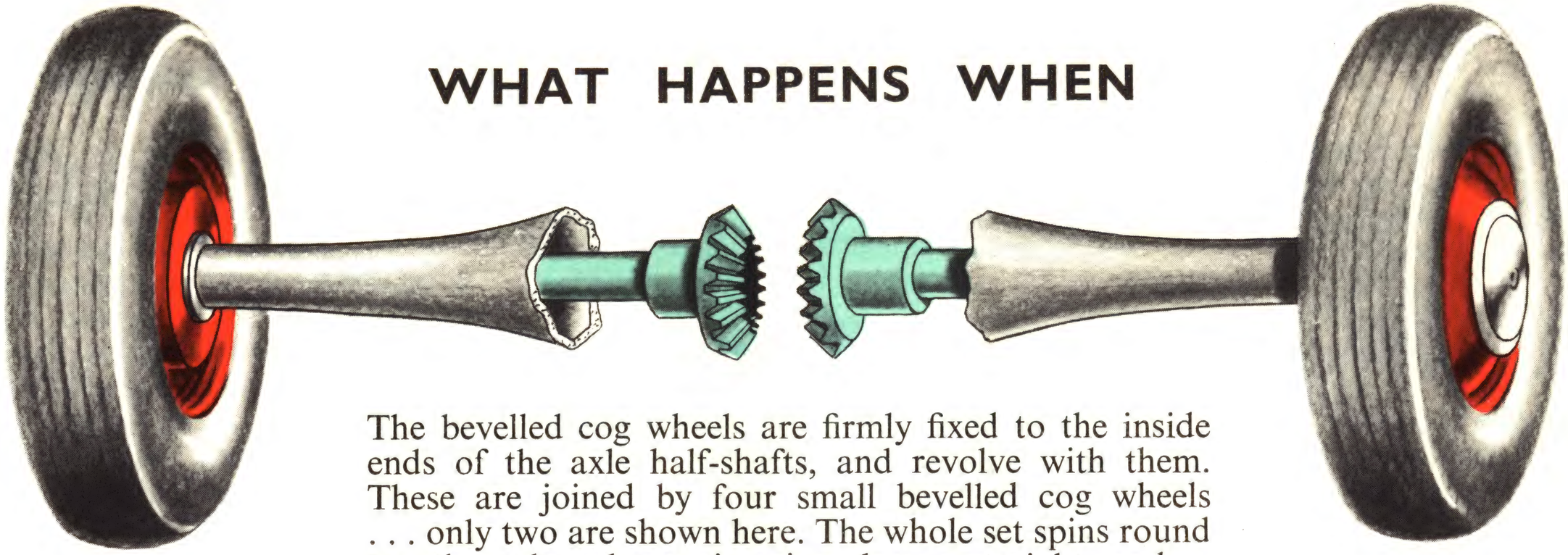


Inside the differential cage are four small bevelled pinions that fit into each other, and into the two cog wheels that are fixed to the two axle half-shafts.

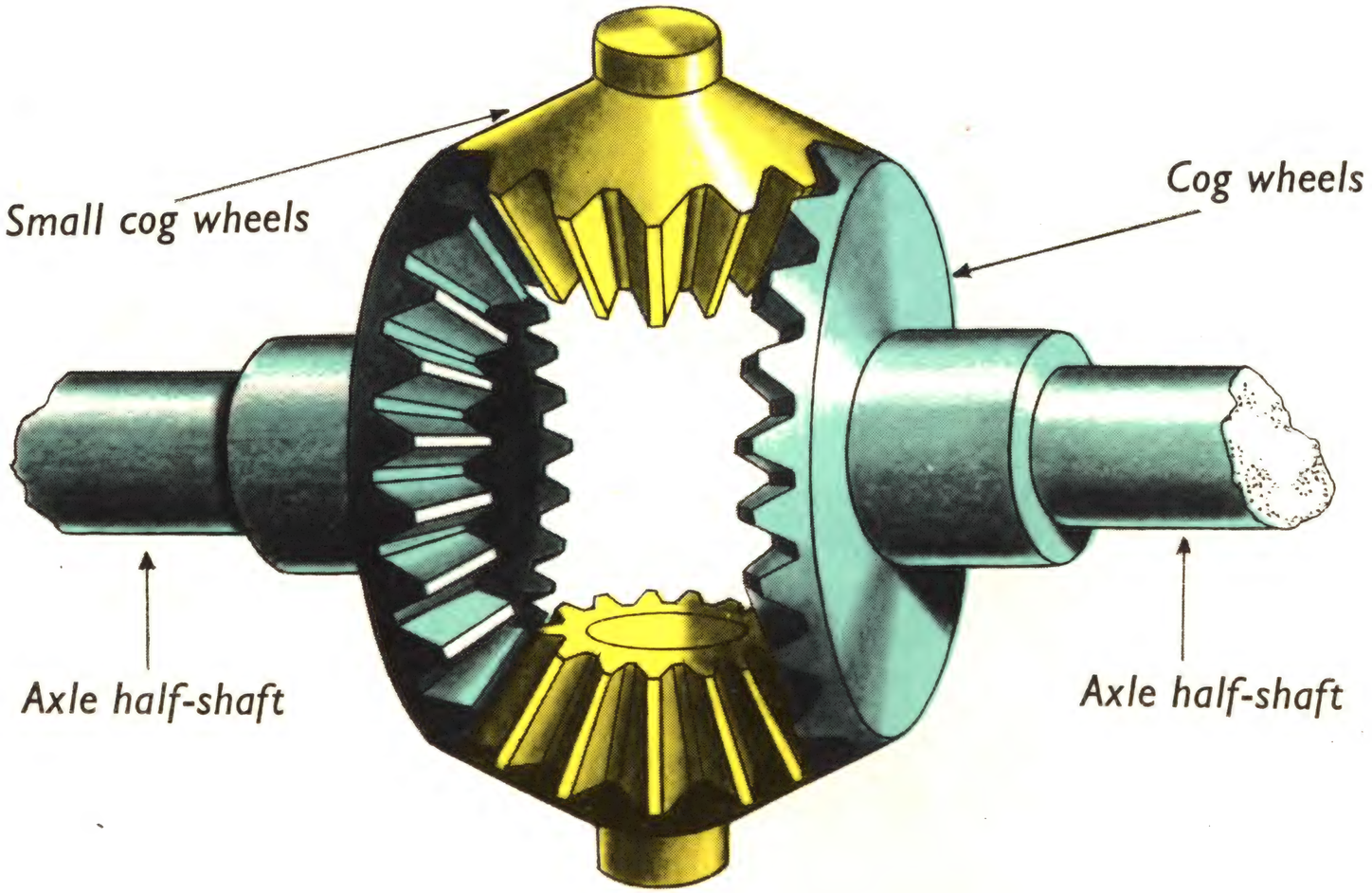
The differential cage is bolted to the crown wheel and the whole lot protected by an outer casing.

When the car turns a corner these cog wheels allow one road wheel to travel faster than the other one in the same length of time.

WHAT HAPPENS WHEN

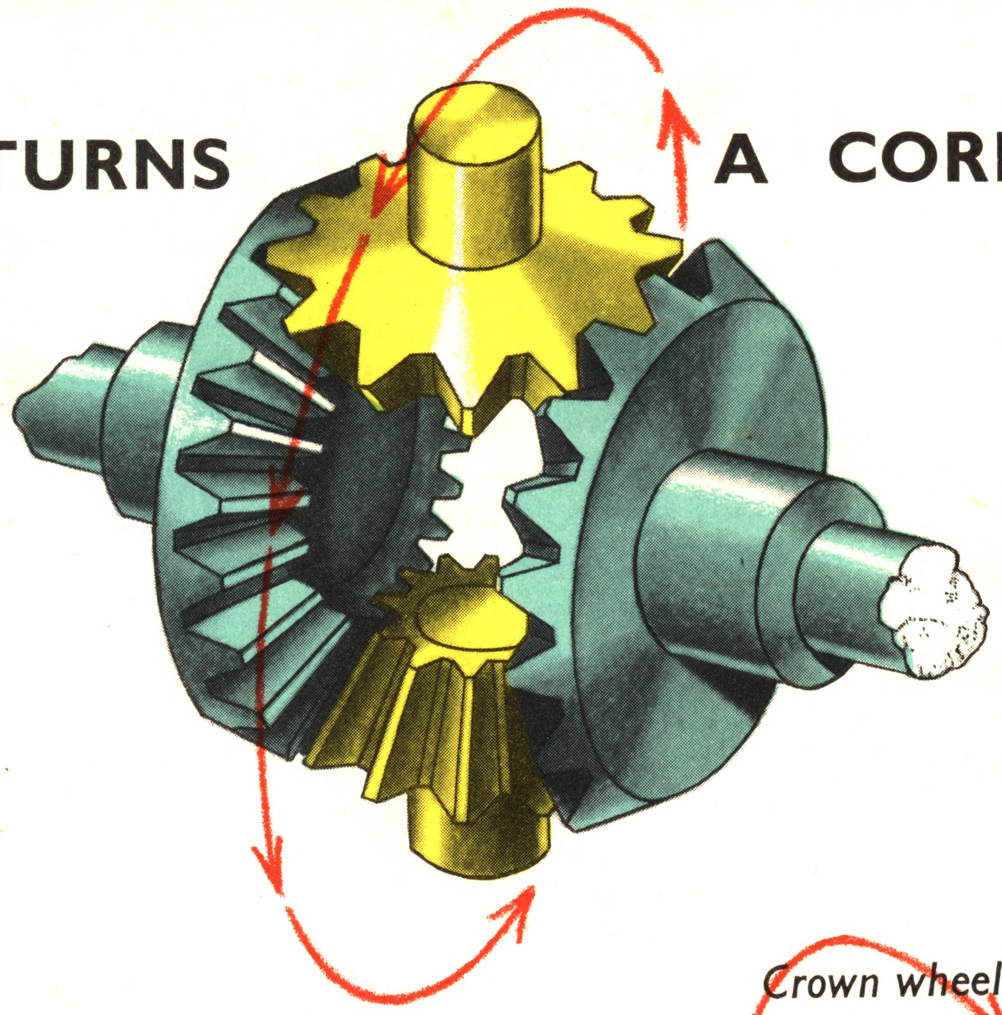


The bevelled cog wheels are firmly fixed to the inside ends of the axle half-shafts, and revolve with them. These are joined by four small bevelled cog wheels . . . only two are shown here. The whole set spins round together when the car is going along a straight road.

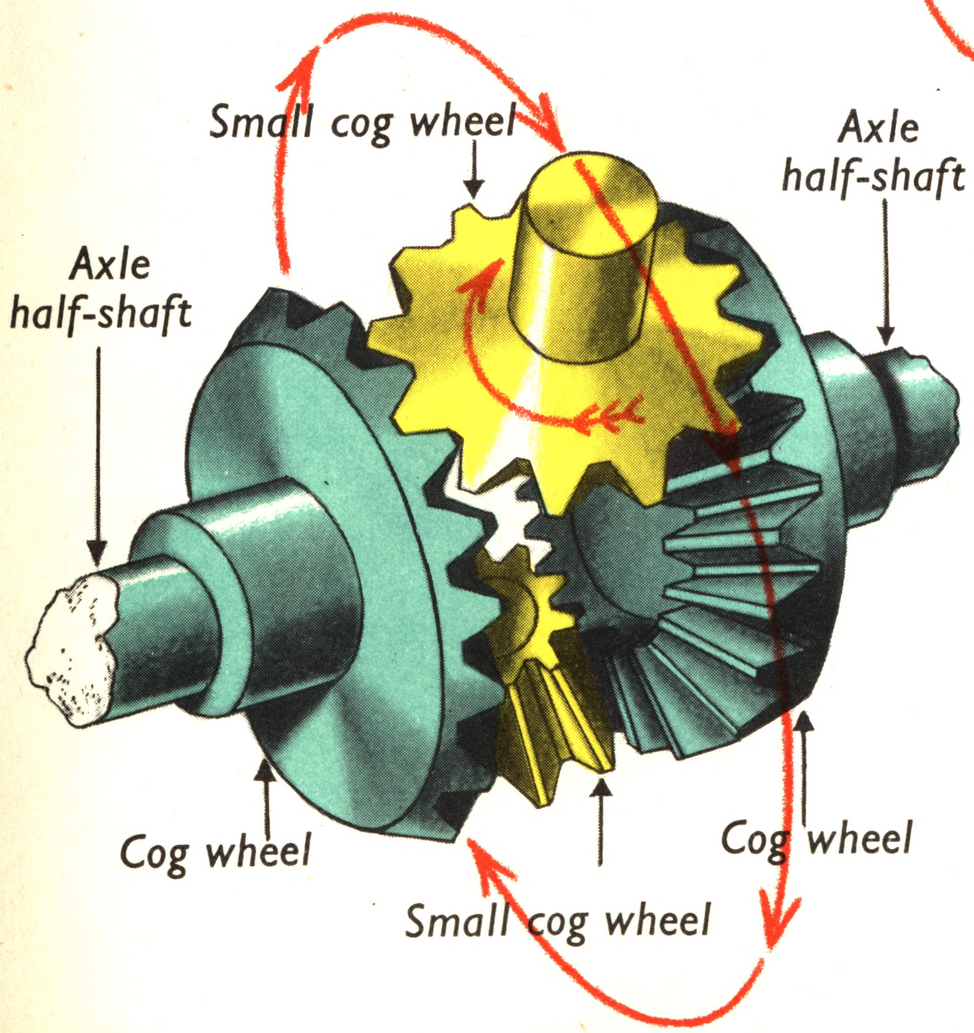


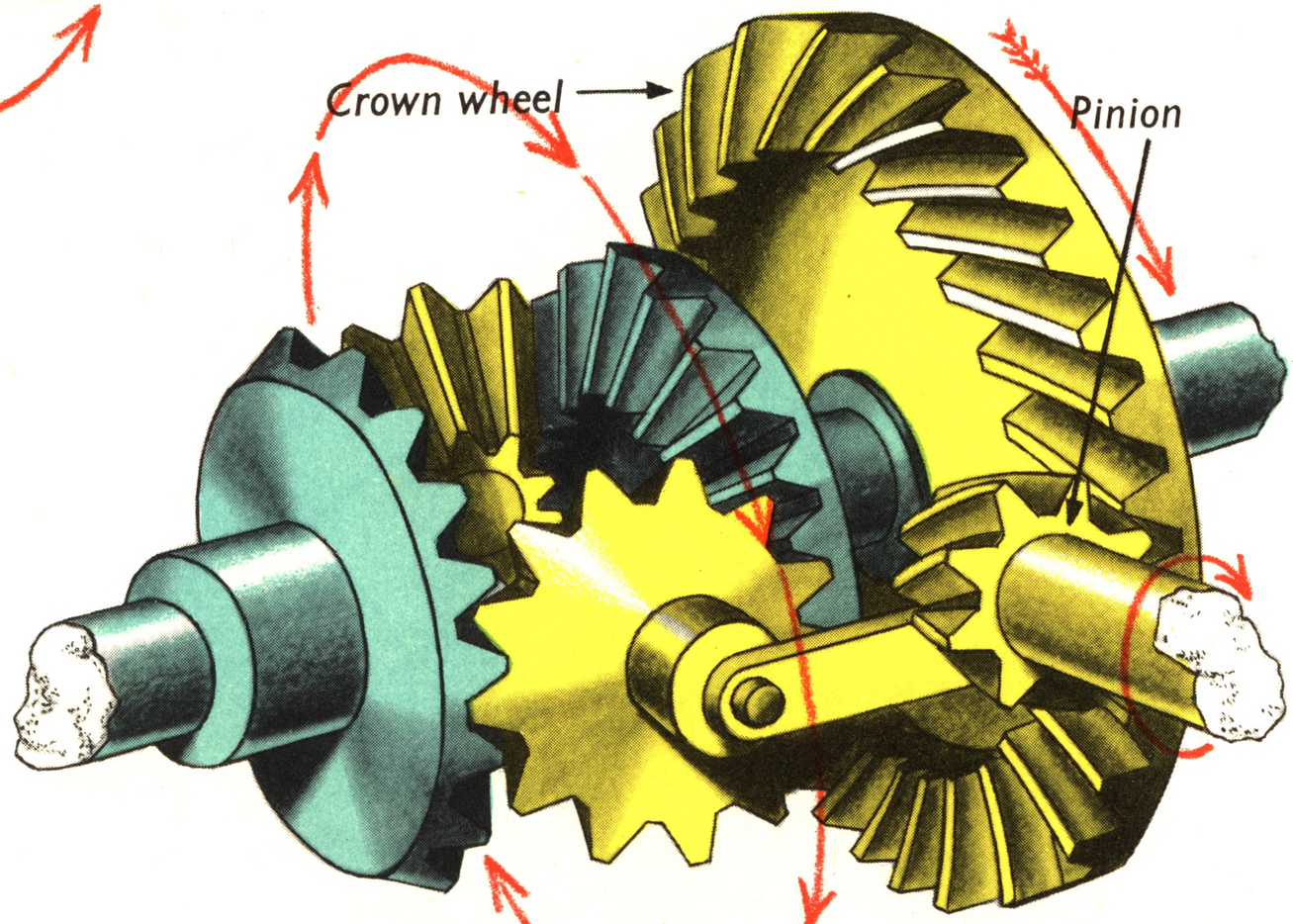
THE CAR TURNS A CORNER

When it turns a corner, and one road wheel goes faster than the other, the cog wheel at the other end of the axle shaft will go round faster too.
The small bevelled cog wheels in the centre then revolve round and round as well as with the cog wheels on the axles.



The crown wheel is put on one of the axle shafts so that it can revolve on its own without taking the back axle with it. This set of cog wheels is then bolted to the crown wheel. These bolts are the only connection between the propeller shaft and the back wheels.





Cog wheels that makes up the differential

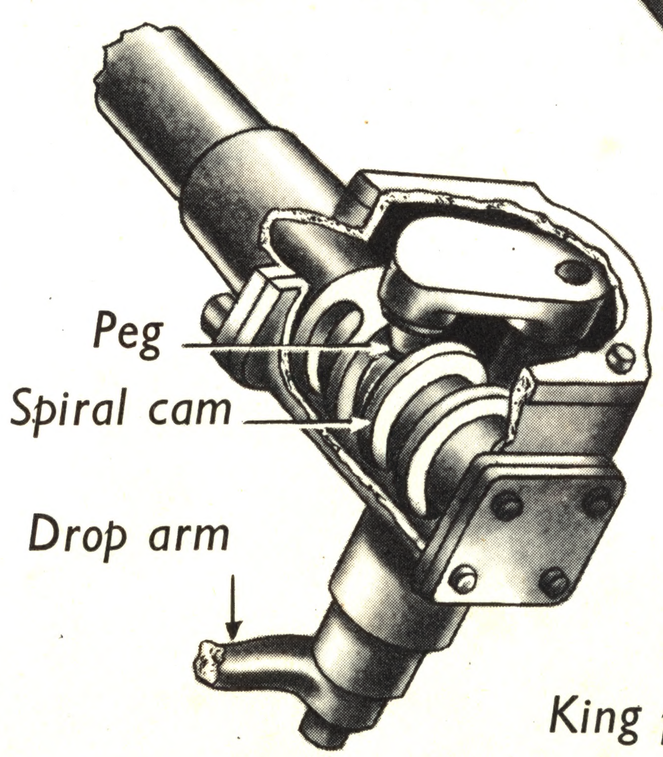
The Steering Wheel

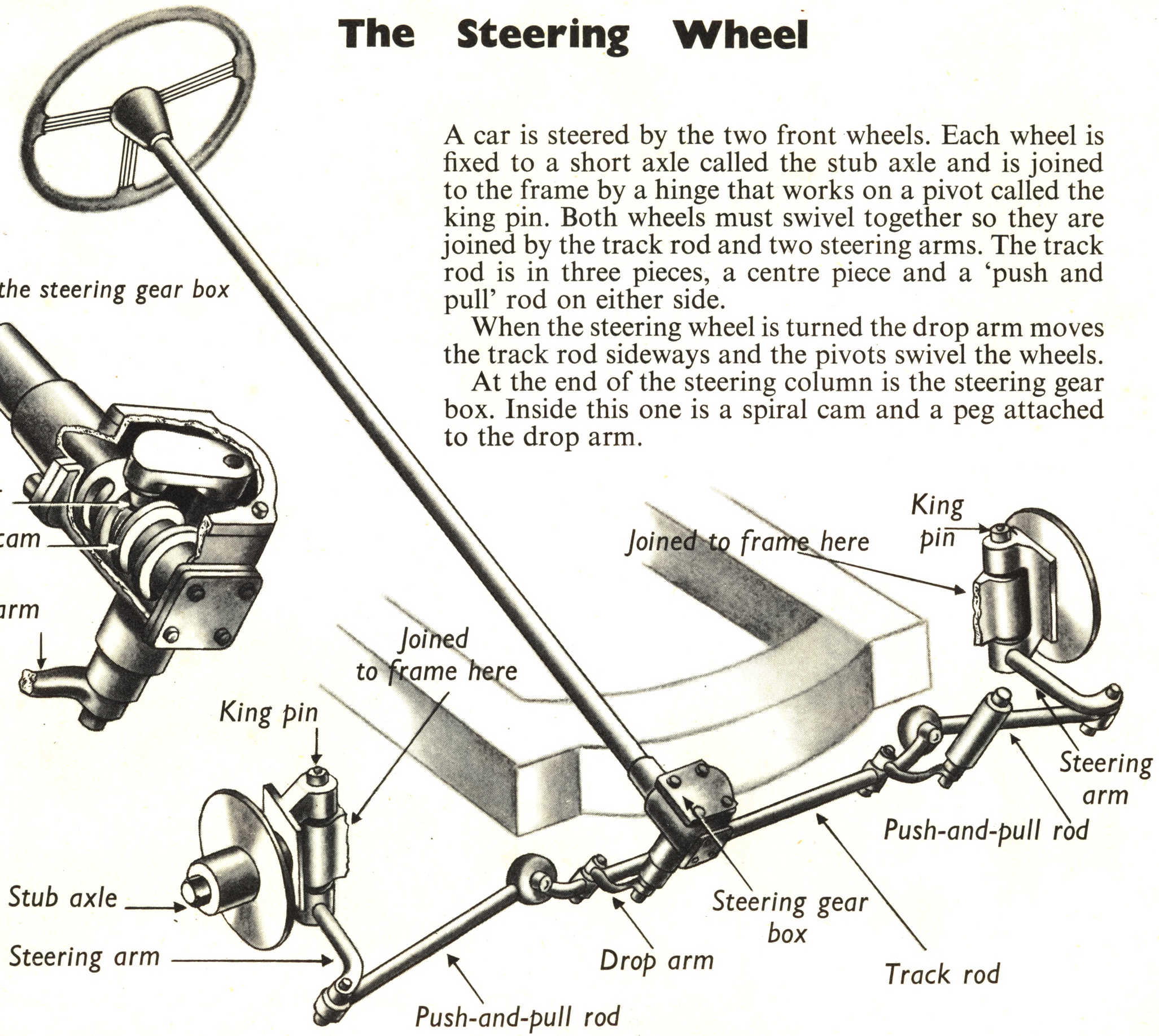
A car is steered by the two front wheels. Each wheel is fixed to a short axle called the stub axle and is joined to the frame by a hinge that works on a pivot called the king pin. Both wheels must swivel together so they are joined by the track rod and two steering arms. The track rod is in three pieces, a centre piece and a 'push and pull' rod on either side.

When the steering wheel is turned the drop arm moves the track rod sideways and the pivots swivel the wheels.

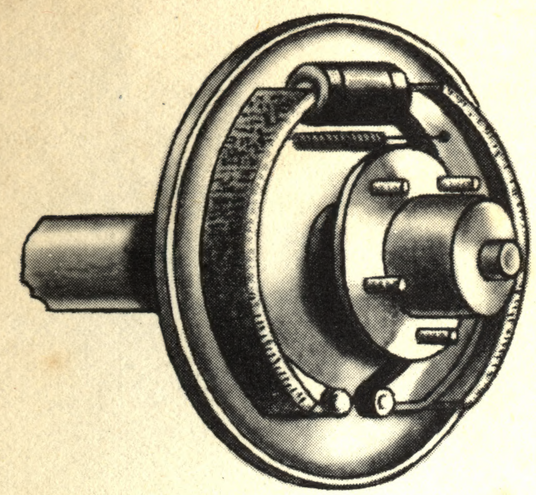
At the end of the steering column is the steering gear box. Inside this one is a spiral cam and a peg attached to the drop arm.

Inside the steering gear box

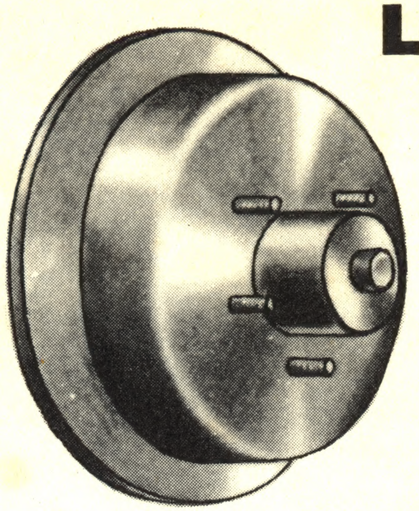




Lockheed Hydraulic Brakes

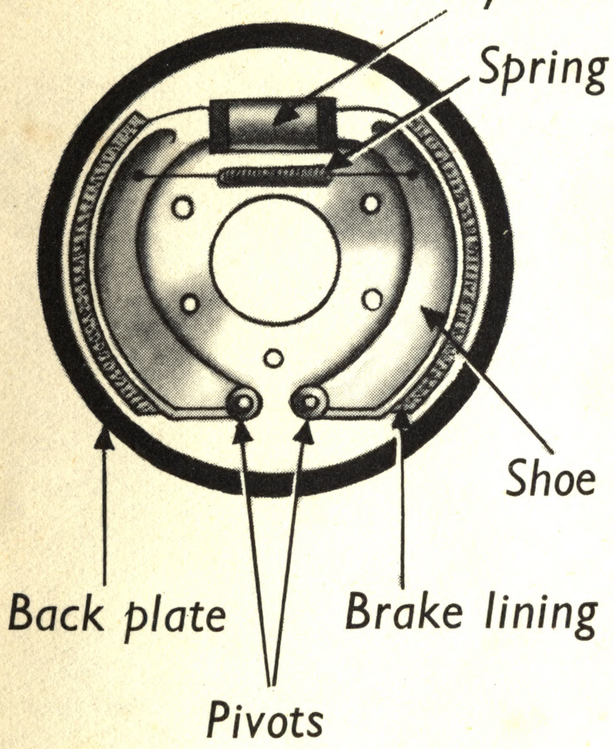


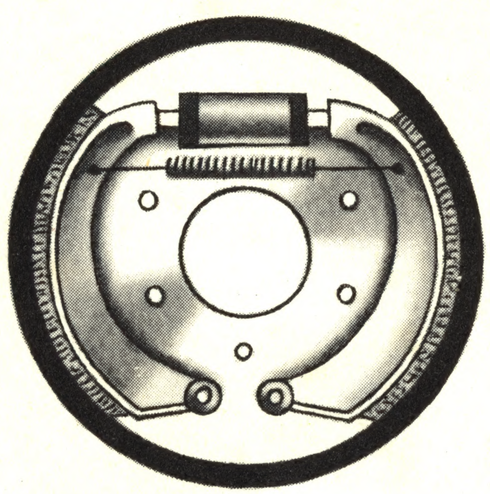
OFF

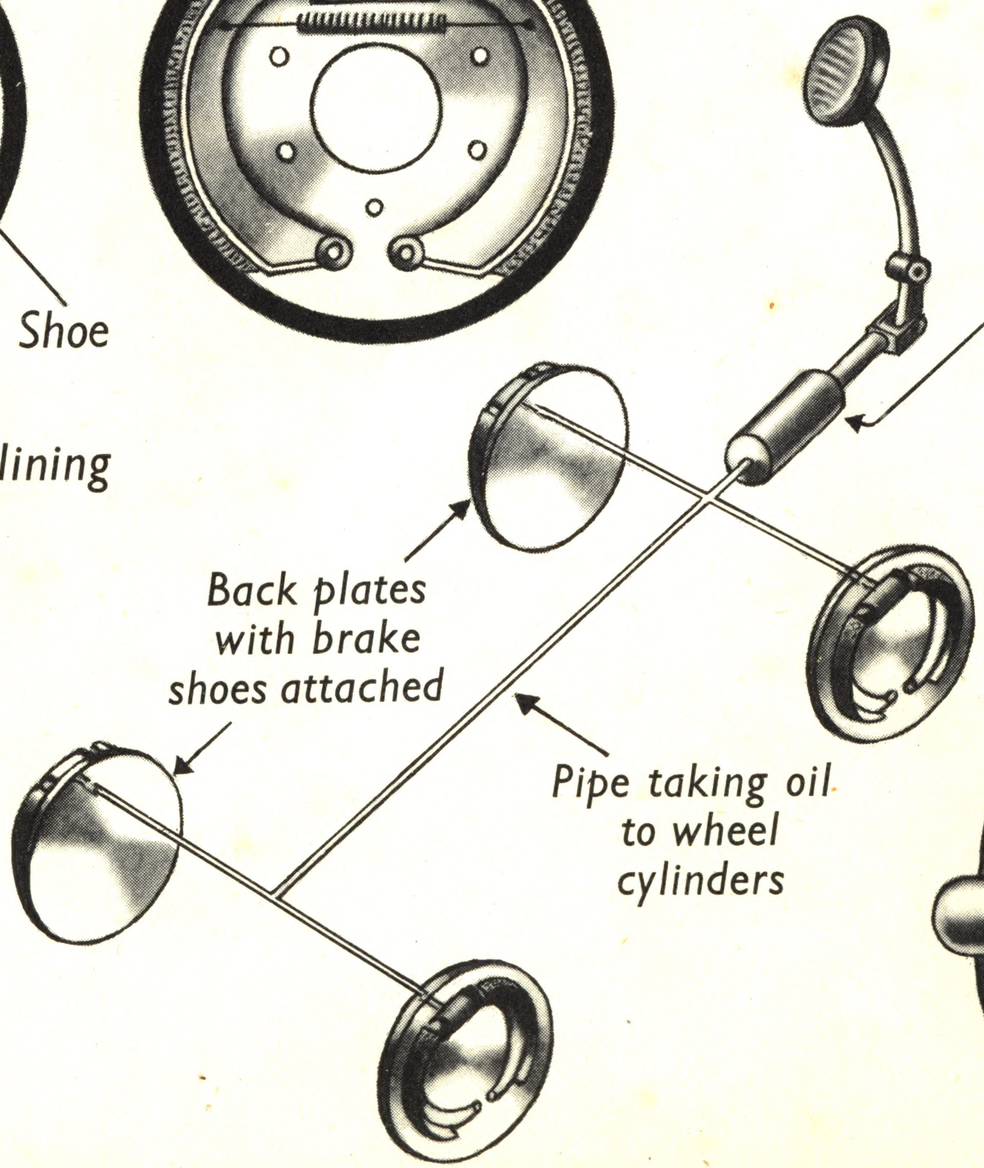


ON

There is a brake on each wheel and a foot pedal works them all at the same time. The hand lever works the back brakes independently by rods and cables. There is a steel drum bolted to the wheel and a back plate with two brake shoes in it fixed to the axle. These shoes are lined with an asbestos fabric. When the brake is put 'on' they move outwards by means of the piston rods at each end of the cylinder and rub against the drum, slowing down the wheel. A spring sends them back to the 'off' position.





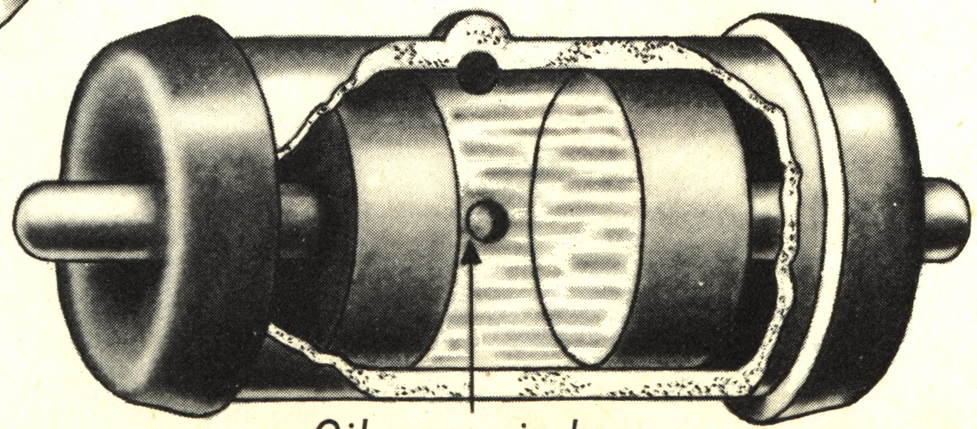


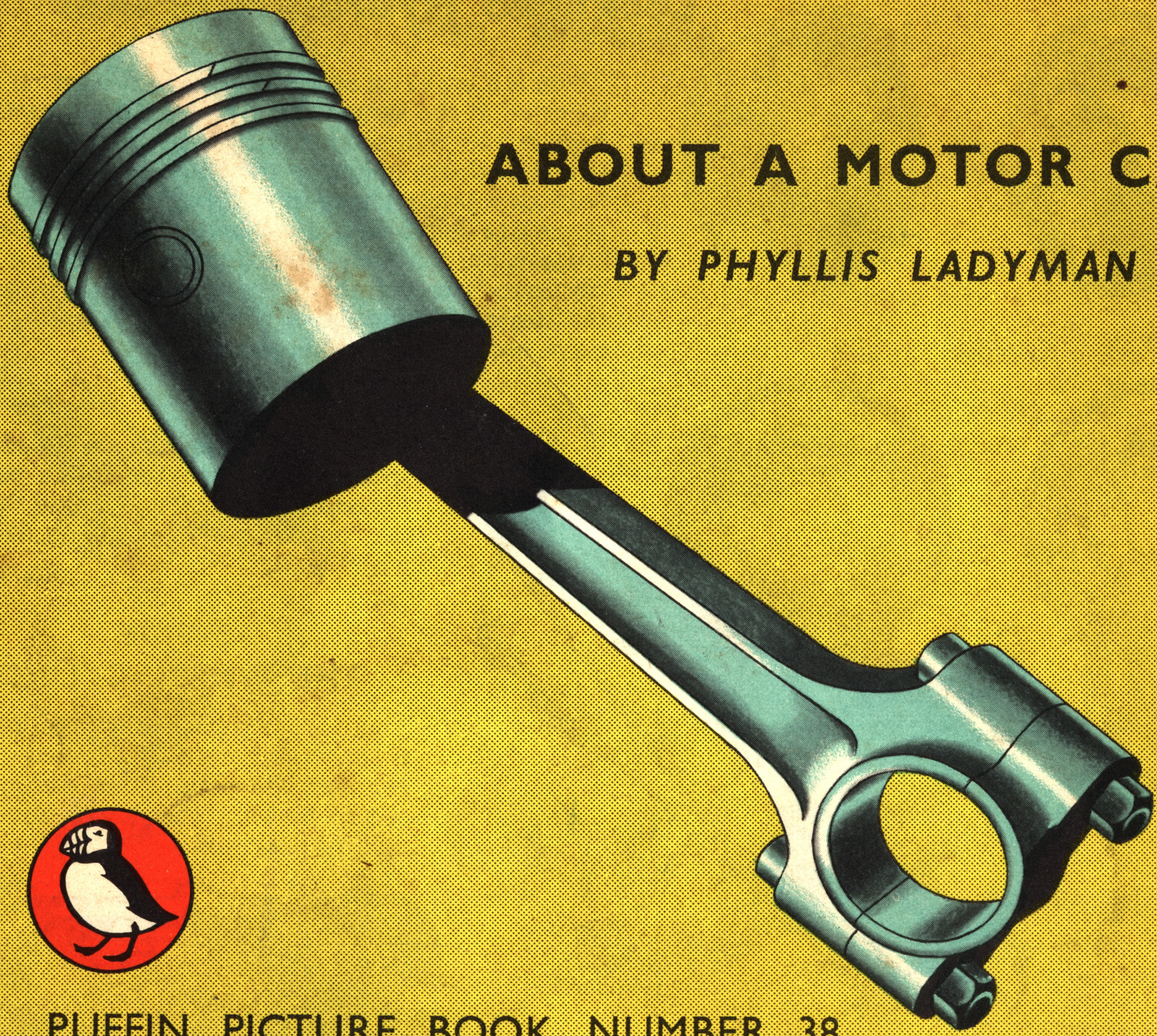
All four brakes must work with even pressure. If one wheel stops before the others it may cause a skid.

This master cylinder is filled with special oil. When the brake pedal is pressed down the oil is forced through the pipes to the cylinders in each wheel.

INSIDE THE WHEEL CYLINDER

There are two pistons with oil between them. When more oil is forced into the cylinder the pistons are pushed outward, making the brake shoes rub against the drum.





ABOUT A MOTOR CAR

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PUFFIN PICTURE BOOK NUMBER 38